THE AMERICAN
GAS LIGHT JOURNAL
REDMANKENNY.N.Y.
PUBLISHING OFFICE No. 32 PINE STREET
DEVOTED TO THE INTERESTS OF ILLUMINATION, HEATING, MECHANICAL, CHEMICAL AND GENERAL SCIENCE.

VOLUME LXXIII.—No. 17. Whole No. 1,324. | NEW YORK, MONDAY, OCTOBER 22, 1900. | $3 PER ANNUM, IN ADVANCE.

A. M. CALLENDER & CO., Proprietors. C. E. SANDERSON, Manager. THOMAS J. CUNNINGHAM and ELBERT P. CALLENDER, Editors.

ENTERED AT THE POST OFFICE AT NEW YORK, N. Y., AS SECOND-CLASS MATTER.

CONTENTS.

An Asterisk (*) denotes an illustrated article.

EDITORIALS —
Special Editorial Correspondence.—By Telegraph.—The Denver Meeting of the American Gas Light Association 641
Experiments on the Reheating of Compressed Air 642
The Unprofitable Consumer, by Mr. Norton H. Humphrys 643
No Gas Franchise for Dover, N. J. 644
The Decision of the Massachusetts Board of Gas and Electric Light Commissioners in the Matter of the Petition for Cheaper Lighting Rates for Fitchburg 645
*The Coal Fields of the Philippines, by Mr. G. D. Rice 645
The Design of Steam Power Plants.—No. V.—By Mr. Henry C. Meyer, Jr. 647
The Ethics of Insulating Materials, by Mr. J. Wright 649
Trials and Troubles of Instituting and Enforcing Municipal Control, by Mr. M. G. Canfield 650
Some Recent Work on the Diffusion of Gases and Liquids 651
Electric Furnaces 652
ITEMS OF INTEREST FROM VARIOUS LOCALITIES 653
Cheaper Gas for Paterson and Passaic, N. J.—Good Prices for Gas Shares—Executive Management, Decatur, Ills.—The Home Gas Company, Steelton, Pa.—Annual Meeting, River Shore Company, Riverton, N. J.—The Presidency of the Essex and Hudson (N. J.) Company—Mr. H. H. Kelley in Full Charge at Waltham, Mass.—Death of Max A. Baum—To Increase the Capital Stock, North Adams, Mass.—A Hint from Tyrone, Pa.—Cheaper Gas for Santa Rosa, Cal.—The Bay State Gas Suits—Itinerant Meter Inspection—Political Blackmailing in Texas—A Norwegian Gas Power Plant—And Other Items.
The Market for Gas Securities 655

[Special Editorial Correspondence.—By Telegraph.]

THE DENVER MEETING OF THE AMERICAN GAS LIGHT ASSOCIATION.

BROWN PALACE HOTEL, DENVER, COL., Oct. 18, 1900.

Dear JOURNAL: The business sessions of the 28th annual meeting of the American Gas Light Association have just been satisfactorily concluded, although it may not be truthfully denied that through it all was a feeling of sadness that would not be repressed. Originally Denver was named as the meeting place with the main thought that Mr. George Treadway Thompson, who had been obliged to seek the climate of Colorado for relief from the physical ill that oppressed him, would be able to share in the sessions and their fraternality. Death, however, intervened, but that he was well and lovingly remembered was in evidence through the constant references made to him during the meeting.

The Association was vouchsafed beautiful weather, the local committee had not omitted a thing in the preliminary preparations for the housing of the delegates and the selecting of a suitable meeting room, the attendance was excellent, the officers were alert and capable, the technical proceedings were interesting and the attention of the members thereto was noteworthy. Now for the proceedings as these occurred. President George G. Ramsdell, urbane as usual, and with the memories of his recent attendance at the International Gas Congress still fresh in his mind, had the satisfaction on mounting the platform of calling to order an assemblage of 120 or more, which assemblage was truly representative of the American gas industry, since the East and the West, the North and the South shared the delegates. The applause that followed his announcement that the regular order was on had hardly terminated when the reading of the report of the Council was underway. The main feature thereof was as to the election of new members. The report (which was of course adopted), recommended the election of M. Theodore Vautier, the distinguished Frenchman who presided over the deliberations of the International Gas Congress, and who served the French Association of Gas Managers as its President for at least two terms, to Honorary Membership, and the adding of the names of 36 active and 12 associate members to the rolls. Secretary and Treasurer Forstall then read his annual reports, which showed how well the Association was prospering, after which came the annual report from the Trustees of the Educational Fund. The facts presented thoroughly go to show the good work that is thus being accomplished on these lines under the auspices of the Association. General Manager Poole, of the Denver Gas and Electric Company, whose activity in connection with the local entertainment committee will long be pleasantly remembered, having announced an extra outing to Silver Flume, over the Colorado Southern Railroad into the "Rockies," the Association listened to the report of the Research Committee on the Edgerton Standard, which report was read by Mr. A. S. Miller. Next came the report of the committee to nominate officers. The final result of the report and the voting was the election of the following named office bearers:

President.—Edward G. Pratt, Des Moines, Iowa.
First Vice-President.—William R. Beal, New York.
Second Vice-President.—Alten S. Miller, New York.
Third Vice-President.—Rollin Norris, Philadelphia.
Secretary and Treasurer.—A. E. Forstall, Montclair, N. J.
Members of Council.—C. F. Prichard, James Ferrier, George McLean and W. A. Miller.

The response by Mr. Pratt to his promotion was eloquent and earnest. The President's address was the next number on the programme, and it proved to be what everyone thought it would, a clever, practical, sensible paper, that will bear close study with profit to the student. Its reading was frequently interrupted by applause. Secretary Forstall then read several letters regretting the inability of the writers to be present at the convention. After the naming of one or more special committees, Dr. Auer von Welsbach, of incandescent gas burner fame, was elected to Honorary Membership, following which came many sorrowful and eloquent testimonials to the memory of George Treadway Thompson, the tributes ending in a fraternal resolution expressive of the sentiment of the Association over the loss it had sustained. The resolution was presented by Mr. E. G. Cowdery. It was seconded on behalf of the Western Association by Mr. William McDonald; by Mr. C. F. Prichard, for the New England Association; and by Mr. E. C. Jones, for the Pacific Coast Association; and was adopted by a rising vote. The report from the Research Committee on the Harcourt standard was then read by Mr. Rollin Norris. The discussion was had on both reports, and an interesting debate resulted. President Ramsdell

subsequently named Dr. E. G. Love as one of the American representatives on the International Committee arranged for at the French Congress, appointed for the purpose of determining "A set of conditions for the regulation of the photometry of incandescent gas mantles."

The President having appointed a committee to award the Beal medal (Messrs. A. C. Humphreys, W. H. White and E. McMillin), the paper list was unfolded. The first to engage the meeting was the paper by Mr. A. H. Barret, Engineer to the Louisville Gas Company, who wrote on the subject of "Inclined Retorts." It is needless to say that Mr. Barret's presentation of the subject attracted close attention. With the courage of his convictions—and it is also needless to say to those who know him that he has convictions, courage and engineering skill—Mr. Barret, having visited Europe some years ago with the express purpose of determining whether the inclined retort principle and practice, as exemplified in Europe, would be the policy for him to follow in the reconstruction of the generating house of his Company, returned home convinced that the principle and practice were the ones for him. The result was the construction of such an equipped house, and his paper detailed the results so far obtained in it—the benches have been under fire for something over two months. Without elaboration he gave a clear statement of what his Company had done in this line, and it may not be gainsaid that Mr. Barret and his Company are well satisfied with the outcome of their labors. Naturally, the discussion on the paper was prolonged and spirited. The business sessions of the first day were brought to a close by the discussion evoked in the reading by the Secretary of the short topic describing the "Repair of a Broken Thirty-Inch Outlet Pipe from a Gasholder." A good practice instituted at this convention was to hold the business meeting in one long or continued session—for instance, the session the first day (Wednesday, 17th inst.) was convened at 10 A. M., and adjourned at 2 P. M

The first thing of especial interest in connection with the second day's proceedings (Thursday, 18th inst.) was the naming of Boston as the next place for meeting, after which the Association settled down to listen to a most interesting and forcefully delivered lecture, by Dr. E. G. Love, of New York, whose theme was "The Theory of the Incandescent Gas Light." The frequent applause that greeted him was sufficient evidence of the closeness with which his hearers followed his scientific and eloquent discourse. The short topic entitled "The Removal of Tar from Water Gas," read for Mr. W. C. Morris by Mr. Alten S. Miller, followed. The next number was the short topic "Gas Advertising," read by Mr. Frank W. Frueauff, Secretary of the Denver Gas and Electric Company; the gentleman by-the way was elected to membership at this meeting; and if he keeps going along as smoothly as he did at his start he will be heard from again, with gain to the Association and with advancement to himself. Mr. Henry L. Doherty next advocated with such vigor his scheme for the forming of a National Bureau of Advertising that the American Association consented to appoint a representative on the general committe that is being formed from other Associations to put the scheme in practical effect. The paper by Mr. W. C. Anderson, of Norristown, Pa., on "The Use of Cards for Records and Accounts," proved a well put together number and brought out a very entertaining discussion, an important contribution to which was a written chapter, by Mr. Walton Forstall. The next matter was a short topic, the burden of which was connected with "A Blue Glass Pyrometer." The report of the Committee on President's Address followed, and as a sequel thereto a motion to appoint a committee of three, to report next year a standard system of keeping accounts, was adopted. Then came the paper by Secretary Forstall, on "Governmental Control of the Price of Gas." A studious and interesting number it was, and it is regrettable that the passing of time restricted the debate thereon. The paper listed from Mr. Jas. H. Walker, of Milwaukee, Wis., was not read owing to his inability to be present at the meeting. The report of the Committee on Final Resolutions, read by Capt. W. H. White, wound up the set proceedings, and closed the technical sessions of a meeting that lacked nothing from any standpoint, so far as professional interest and its advancement are concerned. Gen. Adee, of the Union Pacific Railroad, has seen to it that there will be no trouble over the availability of the certificates, which will be good to the 31st inst., and this means that the outing will be largely attended. The outing trips have been well planned, the weather is perfect and much pleasure is in store for us on the morrow and certainly the day after. The local committeemen know their business well. It might be proper to add that the young ladies will assume charge of the Association on the occasion of the special outing that is to be given under the invitation of the Denver Gas and Electric Company.—C.

Experiments on the Reheating of Compressed Air.

In a paper on this subject, read before the British Association by Mr. William G. Walker, said Mr. Patrick Y. Alexander, of the Experimental Works, Bath, England, and himself, had, during the past few months, at Chiswick and elsewhere, carried out some experiments on the reheating of compressed air. Condensing his remarks, he noted that considerable economy can be obtained by reheating compressed air before admitting it to the engine. Reheating is accomplished by two methods: 1. Ry passing the air through hot pipes heated by a furnace fire. 2. By passing the compressed air through water in a boiler at a temperature depending on the pressure in the boiler. The former is called the dry method, and the latter the wet or moist method of heating. It has long been the custom in Paris to use a small stove, through which the compressed air is passed before being used in the motor. Professor Unwin, F.R.S., states that "Professor Riedler tried an old 80-horse power steam engine in Paris which had been adapted to act as an air motor, and which was actually giving 72 indicated horse power with compressed air at 5½ atmospheres. It was using about 31,000 cubic feet—reckoned at atmospheric pressure—or about 2,376 pounds of air per hour. This air was heated to a temperature of about 300° F., by the expenditure of only 15 pounds of coke per hour. On a favorable assumption a steam engine working to the same power would have required ten times this consumption of fuel at least." Professor Unwin also says that reheating has the practical advantage of raising the temperature of exhaust of the motor, and for the amount of heat supplied the economy in the weight of air used is surprising. "The reason of this is that the heat supplied to the air is used nearly five times as efficiently as an equal amount of heat employed in generating steam." The author and Patrick Y. Alexander have, during the past few months, carried out a number of experiments on the reheating of compressed air by the wet method—*i. e.*, by forcing compressed air into a boiler containing water—when very economical results were obtained.

Last year Professor J. T. Nicolson carried out some very valuable experiments in Canada under the auspices of the Taylor Hydraulic Air Compressing Company. Professor Nicolson experimented with five different methods of using compressed air in an ordinary steam engine of the Corliss type of about 27 indicated horse power. 1. The air was supplied to the engine cold. 2. Steam was injected into the air in the main pipe before supplying it to the engine. 3. The air was injected among the water in the steam boiler and heated by mixing with the water and steam of the boiler before being supplied to the engine. 4. The air was blown upon the surface of the water in the steam boiler and heated by mixing with steam in the same, before being used to drive the engine. 5. The air was passed through a tubular heating vessel and heated by a coke fire, afterward being used to work the engine. The compressed air was drawn at a pressure of 53 pounds from the 6-inch main air pipe of the Taylor air compressor. The author gave an account of this compressor at the Bristol meeting of the British Association, 1898. The wet heating was carried out in a Lancashire boiler 7 feet in diameter by 30 feet long.

Experiments were first made without reheating, when about 850 cubic feet of free air were used per indicated horse power per hour. The air was then heated to 287° F., by passing the compressed air through pipes heated by coke, under which condition 640 cubic feet of free air was used per indicated horse power per hour, being a reduction of 210 cubic feet of free air per indicated horse power per hour, due to reheating. Thus a saving of 25 per cent. is effected in the quantity of air used. This saving was effected by the burning of 0.348 pound per horse power hour. The results may be stated as follows: 100 horse power in cold compressed air was raised to 133 horse power when reheated to a temperature of 287°F., by an expenditure of 47 pounds of coke per hour, or at the rate of 1.42 pounds of coke per horse power per hour additional. This is equivalent to an additional horse power for every pound of coal burnt in the heater, which is far more economical than the most efficient steam engine and boiler. By mixing from 10 to 15 pounds of steam per horse power with the air, the quantity of air required was reduced from 850 cubic feet to 300 to 500 cubic feet per indicated horse power per hour. The results showed that the extra horse power due to heating by the wet method was obtained at an expenditure of 1.3 pounds of coal per additional indicated horse power per hour.

The author's own investigations are most conclusive as to the efficiency of reheating either by the dry or wet method. Generally speaking, the results show that an additional horse power can be obtained with an expenditure of 1 pound of coal. Better results even than this have been obtained, which is far more economical than the most efficient engine and boiler using steam ever produced. And the experiments seem to show that in many cases it would prove advantageous to use compressed air in conjunction with steam in an ordinary engine.

The Unprofitable Consumer.

By Mr. Nort n H. Humphrys, in *Jour. of Gas Lighting.*

It is somewhat disappointing to find that an article on slot consumption and paying averages communicated to the *Journal* some time ago (p. 523) by Mr. George Helps has not been successful in drawing some discussion or expressions of opinion from the friends of the slot meter consumer or from the advocates of the system, and especially from those who go so far as to claim that there should be one price for all—slot or ordinary—and that there should not be an extra charge on the slot meter consumption. At the present time, when the unusually high price of coal leads the gas manager to scrutinize the expenditure side of the revenue account more auxiously and closely than ever, it is desirable that the slot meter should be placed upon its trial, to see whether it really does, in practice, come up to the standard of the paying average. So long as things are going well and easily, there is not much trouble in getting permission to incur outlay, if there is a reasonable prospect of further business; but when there is an awkward hiatus between the amount required for full dividends and the available balance for the purpose, the new proposal is more severely criticised, and there is a desire to know, not only what the proposed outlay will be, but also the actual return that may be looked for. A loading composed of unprofitable consumers that might escape notice at ordinary times, now becomes an important item. While new business is welcome, it is especially desirable that it should be, if anything, more remunerative than the existing lines; and certainly it should not be less so.

The noticeable sympathy between the topics discussed by gas managers in America and those that attract attention here, to which I have previously alluded, is again illustrated. For within a day or two of the publication of Mr. Helps' opinions—which are more remarkable as going beyond the usual standards of the number of appliances put out, or the quantity of gas consumed by them, than for specific considerations of profit and loss—Dr. Powers was asking the members of the Pacific Coast Gas Association, assembled at San Francisco, for some information, not only as to the number of stoves distributed and the quantity of gas used, but as to the actual position of the stove department as a paying concern. Undoubtedly there were increased sales which might be taken to mean increased profits; but he wanted to know the amount of net profit remaining, after paying all expenses, and suggested whether, after charging the gas stove department with all expenses incurred on its behalf, there might not be a necessity for a subsidy from the general funds to meet a deficiency, rather than a balance available for profit. This criticism, being addressed to gentlemen who spend hundreds a year in advertising, or give stoves away *gratis*, might perhaps have greater force in California than in England. But it also applies here, for there is a noticeable tendency to incur special outlay in order to obtain new business, and this without actual proof that the new business may be expected to be remunerative. So the lines of reasoning laid down by Mr. Helps, which admit of an answer to Dr. Powers' question being prepared from the accounts of any particular undertaking, are particularly pertinent under present circumstances of working; and they may be applied to any kind of special outlay undertaken with a view of opening up new lines in gas consumption. In place of "slot meters" we may read "cooking stoves," and the arguments still hold good.

The practice of insisting on a written agreement from every customer has been dropped; and, on the whole, gas companies have done better since they discontinued it, as in some sense it involved thrusting their Act of Parliament upon public notice, and was no doubt largely concerned in securing for them the title of "monopolists." But it is quite possible for the pendulum to swing too far in the opposite direction; and one cannot go very deeply into questions of the kind now under consideration without being confronted by the fact that, while the company on its part accept onerous responsibilities, the consumer incurs no corresponding liability. In laying on a supply of gas, the company has to guarantee a great deal; but the consumer guarantees nothing. In putting down a 10-light meter, with its appropriate service pipe, the company incurs the liability of keeping on a continuous supply for 168 hours per week up to the full capacity of the meter. It would seem that, in order to preserve the two sidedness which is a necessary feature of a fair bargain, the consumer should also be prepared to guarantee a fair minimum consumption. But he can please whether he uses gas for one hour or less, out of the 168, and at best cannot be compelled to do more than make a colorable imitation of using gas. The excess capacity of service and meter that the company is called upon to provide is enormous. A 10-light meter, working at full nominal capacity, would pass more than a million cubic feet a year; but in actual practice, the average annual consumption is less than 100,000 feet. Yet there are those who advocate free meters.

If a gas company decides to assist the consumer by providing a slot meter, stove, or gas lighting appliances, it makes a known and definite addition to its obligations. It has to guarantee the interest on the capital so invested, and to take the risks of depreciation. But the consumer's position is not altered. Every working man may have, not his three acres and a cow, but three gas burners and a stove. The only way of finding out how far the arrangement is likely to be remunerative to the gas company, is to try the experiment for a twelvemonth, and then strike the average, and see if it is a "paying one." The success or otherwise of the enterprise depends solely upon reaching a paying average; and whether this is attained or not rests entirely with the inclination of the consumers. It should be the business of every gas manager who introduces any scheme that adds to the expenditure per consumer, to ascertain his position in respect to this important factor. If it has not been secured, the question for consideration is the best means to adopt in order to convert loss into profit.

One accredited method of proving the success or otherwise of a new departure, is to compare the most recent available set of accounts with those of previous years; and to some extent the balance of income over expenditure is an indication of the prosperity of the concern. But unfortunately the times are not favorable to such a comparison, as this item is affected by variable factors that are outside the control of the management. The market prices of coal and other necessaries have been steadily rising for some years; and it is not always good policy to advance the price of gas in sufficient proportion to maintain the *status quo.* Many who read these lines have experienced the annoyance and disappointment attending upon finding that the results of some improvement involving a large amount of time and trouble have been wiped out of the accounts by these means. They have introduced, let us say, regenerator firing, and have incurred considerable outlay on the faith of improved returns. After the usual difficulties and anxieties, the expected results are fully secured. But meanwhile up goes the price of coal; and the additional profit, which should appear in the form of increased net revenue, simply goes into the pocket of the coal suppliers. It is difficult to satisfy everybody that more profit has been earned, when a smaller return is shown in the profit and loss account. In a similar way, a comparison of the accounts for the year ended June 30, 1900, with those for the year ended June 30, 1896, is not likely to afford much useful information as to the success or otherwise of a new departure inaugurated in 1897. Yet we naturally want to know whether the introduction of the slot system has yielded a profit commensurate with the special expenses, trouble, and risk incurred in connection with the establishment of this new line of business. Whether equally good results might possibly have been attained by less costly methods, and whether the new venture has not been allowed too prominent a place, to the detriment of other means of keeping and increasing business—such, for example, as a well arranged maintenance scheme for incandescent lighting. One company may be very enterprising, and devote all its available strength to obtaining new business, while another may rather favor attention to the existing connection, and to keeping together the business already secured; and it is possible that the second may make as good a showing as the first.

A very usual joke at a Christy Minstrel entertainment is for "Massa Bones" to step forward, after a well merited round of applause accorded to an artistic rendering of a chorus or orchestral performance, and, by elaborate bowings and gesticulations, to accept the same as a recognition of his own individual abilities. The slot meter stands in a somewhat similar position, when it is credited with going out by thousands, while the ordinary meter only went by hundreds. The introduction of the slot also means, in most cases, the inauguration of a grand new policy. It is a very long jump from unassisted gasfitting and long period irregular payments—the benefit of gas could not be obtained on any other terms—to short period regular payments and fittings without trouble or initial cost. Under the ordinary arrangement, the intending consumer is practically loaded with all responsibility in respect to fittings on his side of the meter. He has to employ a gasfitter, to exercise a certain amount of supervision, and then to foot the little bill. In some cases the gas company assists him in this matter to the extent of being prepared to carry out the gasfitting at his expense. Then as regards payment for the gas consumed, until the introduction of the slot meter the idea of doing business on any other than "quarterly terms" was regarded, with very few exceptions, as impracticable. And to talk of quarterly payments does not quite cover the whole ground, as the

impression is conveyed of *equal* payments, as is the custom with regard to the rent of a house or field. But the quarterly terms for gas really come, in practice, to paying one-third in January, one-third in April, one-sixth in July and one-sixth in October. Thus a consumer using £10 worth of gas per annum is asked to pay £3 in January, and a similar sum in April. There is no trouble about the summer instalments. But the small consumer and the weekly wage earner find their January and April payments are a heavy burden, coming just at a time when other expenses are highest and wages lowest. With the slot system there is no heavy initial expense in the form of the gasfitter's bill; and in regular working there is no quarterly bill looming in the distance, and no necessity for scraping together comparatively large sums during the winter months. As Mr. Helps appropriately points out, there are other ways of securing these advantages, apart from the slot meter; and in assessing the benefits claimed to have resulted from its introduction, it is right to discriminate between those due to the special feature of the appliance, and those due to fittings with no initial cost and to short period payments.

There is a point where every consumer of gas—and, for that matter, every purchaser at any shop—ceases to be a source of profit. Let us suppose that a customer's account is subject to steady and continuous decrement. After a time, a point will be reached when the custom is so small that, to use everyday language, it is not worth having. The grocer would decline to sell sugar or soda by the ounce; and the publican would not care to retail beer or spirits by the halfpennyworth. The reason why they refuse to do so is that every transaction involves a certain special outlay, if only an assistant's time for a few minutes. In connection with the sale of any commodity, there are three classes of expenses—viz., liabilities, such as rent, which are entirely independent of the amount of business done, and have to be paid in any case; expenses, such as the purchase of materials, which are in direct ratio to the amount of business done; and expenses that vary according to the number of customers, such as the serving and delivery of goods. In regard to the supply of gas, there are certain establishment charges which must be met, even if the company did not sell 1,000 cubic feet of gas. There is the cost of coal, wages, purifying and other items of manufacture, which depend upon the quantity of gas made; and there are the salaries of meter inspectors, rental clerks and collectors, cost of bills and receipt books, which depend upon the number of consumers. We will call the establishment charges A, the manufacturing charges B, and the consumers' expenses C. It is a debatable question whether the establishment charges A should be allocated per consumer or per 1,000 cubic feet of gas sold; but there can scarcely be any difference of opinion as to each consumer being charged with an aliquot share of C. If a consumer is to be of any value to the concern, we find that calling his total annual payment D,

$$D - B > C;$$

and the difference will constitute a contribution to the profit and loss account. If this expression does not hold good, then the customer is a loss, and not a source of profit. The value of C can be readily calculated from any set of accounts. In order to illustrate the point, we will put D as representing 5,000 cubic feet at 3s. 6d., B as equivalent to 2s. per 1,000 cubic feet, and C as 4s. In this case, D — B = 7s. 6d., leaving a margin of 3s. 6d. to be considered as profit. We also find that—

$$2\tfrac{1}{2}\,(D - B) = C;$$

and it follows that the above expression would become a minus quantity at about 2,600 cubic feet. This is exclusive of special expense incurred in the way of meter, stove, or other appliance for the special use of the consumer.

It is immaterial, for the moment, whether the turning point is 2s. or 10s. What I am now seeking to impress is that there is a turning point, or, as Mr. Helps calls it, a paying average, and that any customer whose account does not come up to the point is a source of loss. The question is: What is to be done with the unprofitable customer? No one likes the idea of refusing business, even if the profit is not very apparent. There is a vague impression that the injury incurred by refusing a customer can scarcely be estimated; and so any retail dealer would assure us that he works certain lines at a loss, because by this means he keeps business together. In a similar manner, all gas companies are loaded with a number of small and irregular customers whose business is not worth having; but under the terms of their concessions, they are supposed to supply anybody and everybody, irrespective of the "turning point" or of the paying average.

The best means of meeting this difficulty is the minimum charge, which is simply a *quid pro quo* for the special expenses and liability incurred by the company. One speaker at the Pacific Coast Association meeting above referred to, mentioned that he had put this system into operation, and that there had been absolutely no objection raised by his customers. Perhaps in England some might say at first that it was paying for nothing; but the error in this assertion can easily be proved. Such a procedure appears preferable to the absolute refusal to do business on any terms. It is difficult to show, in view of the liability undertaken by the gas company, that a minimum charge of, say, 20s. per annum is either a hardship or an injustice. The minimum charge has been recognized by Parliament in connection with the supply of electricity; and, in a general way, the prescription of length of service pipe, and of guaranteeing to use the equivalent of at least 20 per cent. per annum on the cost, which is a feature of the Model Gas Acts, indicates a recognition of the right of the gas company to be preserved from the unprofitable consumer. In our principal towns, where the habits of the artizan classes are very different from those prevailing in rural districts, there appears to be no difficulty in reaching the paying average; but as much cannot be said in respect to small country towns, consisting chiefly of the class known as "residential," or a sort of center of supply for an agricultural district, with no special manufacturing industry. Mr. Helps shows that the paying average comes in at somewhere about 10,000 cubic feet; and it is by no means certain that this can be obtained by the smaller gas undertakings. They must either adopt a high extra price or a minimum charge, if they wish to be secure from loss. A high extra price is a great injustice to a large slot consumer, and, if the ordinary price of gas is already 3s. 6d. or 4s., is likely to prove a hindrance to business. One essential to a successful slot department is that the gas should be moderately cheap.

While the unprofitable consumer may be got rid of by the drastic remedy of cutting him off, it should be remembered that at the best the company can only recover a portion of its outlay by this means. The meter and the stove may be brought in again, and also the fittings; but there will be a certain wastage of piping, and a considerable portion of the outlay consists of labor. Money paid as wages, when once disbursed, is clean gone; and no portion of it can be recovered. There is also not only the loss on putting in the fittings, etc., but a second expenditure by taking them out. Then there is always a hope that the unprofitable consumer may improve—that having once commenced to use gas, he will from time to time add to the number of burners, put in a gas fire or other gas appliance, etc. It does not seem unreasonable to hope for an increase in the consumption per consumer. If the first year's working of the slot meter averages 8,000 cubic feet per consumer, the second may show 8,500 feet, and the third 9,000 feet. It would therefore be preferable to guard, as far as possible, in the first place, against getting the unprofitable customer on the books; but when there, the cutting off process should not be applied until there is absolute certainty that the case is hopeless.

Gas companies are apt to run too much on the lines of the British agriculturist, who, having been accustomed for years to grow corn on a particular plot of land, and finding he cannot sell the produce at what he regards as a remunerative price, sits helplessly down, grumbles about bad trade, and wants his rent and rates reduced. The American farmer does one of two things. If his corn will not sell as corn, he sets to work and extracts whisky, starch, sugar or other marketable commodity from it; or he drops growing corn that will not yield a profit, and grows potatoes or something else that will. A great deal has been written and said about educating the gas consumer, in the sense of teaching him to avoid wasteful and inefficient appliances; but might not this expression be taken in a wider sense, as inducing the gas consumer to use 2,000 cubic feet of gas where he only used 1,000 feet before?

Surely it is preferable to change the unprofitable consumer, by this sort of education, into a profitable one, than to cut him off. We sometimes hear that a clever shopkeeper will sell people things they do not want, but that any fool can sell them what they do want. This saying is true, not in the sense that the clever salesman induces the customer to buy useless articles, but that he sells some novelty previously unknown to the purchaser, and which affords a good return for the expenditure. Gas companies have kept too closely to the lines of selling "what they do want," and might with advantage study the tactics of the smart counter hand.

THE Fire, Lamps and Water Committee, of the Common Council of Dover, N. J., reported unfavorably on the proposed gas franchise for that place, and the report was sustained by the Council. It is evidently a fact that there will be no gas works in Dover until the local electric light company's controllers build one. It is queer, though, that they did not put up a gas plant at least 5 years ago.

The Decision of the Massachusetts Board of Gas and Electric Light Commissioners in the Matter of the Petition for Cheaper Lighting Rates for Fitchburg.

The following is the text of the decision of the Commissioners respecting the topic named in the headlng:

This was a complaint by the customers of the Fitchburg Gas and Electric Light Company relative to the price of gas and electric light. A hearing was given in Fitchburg, at which numerous customers were heard on behalf of the petition.

The Fitchburg Gas Company was organized, under a special charter granted in 1852, and began to supply gas in the following year. In 1889 the Company was authorized under the general law to engage in the business of supplying electric light and power. It soon after purchased the plant and franchise of the Wachusett Electric Light Company, and has since that time been the only Company supplying gas or electric light in the city.

The Company supplies arc lights of nominal 1,200-candle power for street lighting and for commercial purposes, incandescent lights for interior use, and electric power. The street lights, 265 in number, are run all night and every night throughout the year, at $110 per light. The commercial arc lamps are used mostly in mercantile houses, where they are run from some time in the afternoon, dependent on the season of the year and the weather, until 6 or 6:30 o'clock, and later in the evening one day in every week. The price of these is $7 per month. Incandescent lights and energy for power purposes are supplied by meter, the former at 20 cents per kilowatt hour, with a sliding scale of discounts, ranging from 5 to 20 per cent., according to the size of the monthly bills. The net price for gas for lighting is $1.60 per 1,000, with a further discount to $1.40 to customers who have gas ranges installed, and to certain large manufacturing establishments which use it in the daytime for mechanical purposes.

The capital stock was originally $40,000. This was increased to $60,000, and after the assumption of the electric business to $150,000. It has also an indebtedness of about $45,000 incurred for new construction and represented by promissory notes. Its stock has never been watered, has always been fully paid, and the last $50,000 was issued at 50 per cent. above the par value.

The population of the territory supplied is about 31,000. The Com pany has apparently been liberal and progressive in the extension of its gas mains and electric lines. It has about 23 miles of main pipe, and over 100 miles of wire in use. Its total sales for the year ending June 30th were 24,504,000 feet, making its consumption per mile of main rank with the smaller Companies in the State.

The present price for gas and incandescent electric light went into effect after this petition had been prepared, and on the day when it was filed in this office. A reduction of 20 cents per 1,000 was made in the prices of gas, and a change of incandescent electric light prices was effected through the adoption of the sliding scale of discounts. No changes were made in the arc light prices for commercial or street use.

In considering this petition the Board has made a careful study of the operating expenses, capital and depreciation charges. The first exhibit such economy and skill as not to be open to criticism, but there is serious question whether the policy heretofore pursued respecting the others should be continued.

Reference has been made in former decisions to the relation of plant value to capital as an important factor in determining a fair dividend rate. Economy in management and a conservative administration have enabled this corporalion, through a long series of years, to apply to the development of its gas plant considerable portions of its income which, under a different policy, might have been paid in dividends to the shareholders. In this way the gas plant has attained a high value relative to the actual capital issued upon it, and upon such capital a higher return than would be otherwise permissible may be allowed without prejudice to the public interest.

The facts, however, do not seem to justify the same statement concerning the electric plant and the capital which represents it, although the same skill and economy may have been employed upon it. The great advance in the art of electric lighting and the peculiar conditions surrounding the business in Fitchburg have combined, in the brief time that it has been carried on, to cause a large reduction in the value of the plant as first constructed, and have given no opportunity for repeating in this part of the business the experience of the gas department. The amount of money expended out of income in the effort to maintain an even relation between the electric plant and capital has been necessarily large from year to year, although probably no larger than would have been needed had the two interests continued to be separately managed. Whether the former owners ever realized the fact or not, it is evident that a thorough reconstruction of their plant and a readjustment of the methods of the old Company, involving large annual expenditures, would have been necessary to secure a satisfactory public service.

Prior to the assumption of the electric business, the Gas Company had been earning and declaring annual dividends of 10 per cent. It has since continued this rate without interruption upon the entire capital invested in the electric plant. Apparently it has failed hitherto to fully appreciate the effect of this dividend and maintenance charge upon the prices for electric light. Together they constitute the most important factor in the price. The nearly even relation between the electric plant and its capital seems to justify only a moderate dividend upon the latter, and present conditions require less than heretofore for proper maintenance in both the gas and electric departments. A reduction of the general dividend upon the entire capital and of the charges for maintenance will open the way for the further reduction in price recommended by the Board.

Based upon the facts and principles stated, the Board recommends:

First. That, from and after the date hereof, the net rate to be charged for gas shall not exceed $1.45 per 1,000 cubic feet.

Second. That the price of commercial arc lights, of the type now in use and burning substantially as heretofore, shall not exceed $6 per light per month.

Third. That the price of street lights of the type now in use, and burning substantially as heretofore, shall not exceed $100 per light per year.

For the Board,

BOSTON, Oct. 1, 1900. FORREST E. BARKER, Chairman.

[Prepared for the JOURNAL.]

The Coal Fields of the Philippines

By MR. G. D. RICE.

Since the practical conclusion of hostilities in the Philippine Islands there has been a great deal of prospecting done by representatives of American mining companies, individual miners, discharged soldiers of the army, and even the natives, with the result that all sorts of mineral deposits, including coal of a good quality, have been located and in some instances worked successfully. Your correspondent has recently returned from a trip to Cebu, Negros and Bataan. The finest beds of coal thus far developed are in the island of Bataan, where they extend over a large territory. Since the establishment of the mining bureau at Manila, by which mining papers are cleared and titles to lands sought out and adjusted, there has been a great movement towards the establishment of plants for the operating of the coal mines in the southern section of the Philippines. There are capitalists represented in the enterprises who control large and successful mines in the United States and other countries, and the indications are that within the year there will be important steps made in the working of the mines of the Philippines. In most cases the coal mines have been discovered by the miners who were prospecting for gold, silver, lead, copper or other valuable deposits, which are known to exist in Luzon, Panay, Negros, Mindanao, Gimeras, Bataan and Cebu. On Gimeras there are several mines in operation, but the coal mine there has not been developed to any important extent. On Panay, the coal mines are still in their infancy, and such specimens of coal as have been brought to notice are not of so good a grade as found in the beds of Bataan, Cebu and Negros. Mindanao is an extensive field for the operations of miners, and about the first thing that a new party of miners do when they arrive in the Philippines is to strike out for this island. The miners who have gone to Mindanao usually discover some sort of a mine, for there have been already established there mines for getting coal, iron, gold, silver, lead, copper and other metals.

Coal Mines are Extensive.—According to information secured from the mining bureau, from a number of miners who have prospected for coal, and from personal observation, the coal mines of the Philippines are practically the most extensive of any mineral. The geographical formation of the islands renders it difficult to locate the leads and follow them, but in cases where the prospectors have been successful, the results have proven very encouraging. In nearly all of the places which I visited it seems as if serious eruptions of the earth must have occurred some time in the past, and the results of these eruptions handicap mining. The volcanic eruptions of centuries ago

evidently broke and separated the leads of coal, and the result is that, although the leads often extend over large territory, they frequently break abruptly, and one would suppose that that was the end of the lead. But if he follows the earth a short distance, he will locate the lead again. The eruptions seemed to have broken the leads all through the islands, with a resulting series of short leads.

Tracing the Leads.—But the miners have no trouble in tracing the general direction of these extensive leads. I have been with working parties who have followed the leads from one side of an island to the other without losing the general trend. When a lead stops, the other end, separated by volcanic eruptions, is usually located shortly after. It would seem as if two great belts of coal extended through the archipelago at an angle of about 60° southwest and northeast. The interested parties are buying up considerable of the property in the vicinity of these belts with a view of working the same. The operations, however, are chiefly confined to the islands of Bataan, Cebu and Negros. Hardly anything has as yet been done in Luzon, Panay or other islands, beyond the preliminary preparations. The largest deposits of coal are evidently in the islands of Cebu and Negros, while Bataan has the reputation of having not only extensive beds but a fine grade of coal. From specimens furnished and subjected to the usual tests, the coal is of a tertiary age and a highly carbonized lignite.

Mines Worked Since 1827.—Mining is no new idea in the Philippines. The natives have been getting out coal and using it since 1827. The mining has been done on a small scale, and no works of any sort have been established, because the ladrones and freebooters of the mountains would have destroyed or looted any equipment put up. The mining of coal in the past, like all other mining in the Philippines, has been conducted with the crudest types of instruments, often the miners being supplied only with bamboo bars and wood scoops for shovels. At one

Mining Party Leaving Iloilo for Interior.

place inspected by the writer, where even now they are working a native mine as of old, they did not have a single metal tool. Most of the work seemed to be done by hand. I saw natives use their hands to scoop up earth. They had little hammers made by entwining sharp pointed stones to the end of a stick, and these hammers served as picks and to break off pieces of the coal. This coal has been sold to water craft plying with mails and freight between the islands. It seems that the first coal mines were worked on the island of Cebu, and it is only recently that the better grades of coal on the islands of Bataan have been used. For many years the operations at the coal mines have been very irregular. Sometimes the mines would be operated full blast for a year and then remain idle for a same period. The natives are not inclined to work at mining or at any other operation, unless compelled to for need of money and food. It is only when driven to it that they will get out their tools and go to work. Therefore the best of mines have frequently been shut down for stated periods from this one cause, and, as is well known, it is very unsatisfactory to operate any kind of mines on this plan. I recollect in one instance where they stopped work, the mines flooded and considerable expense was entailed in getting the mine back into a paying order.

The Mine of Uling-Uling.—One of the chief mines of the Philippines is known commercially as "Uling-Uling," and it is located on the island of Cebu. The coal from this mine is said to be better in quality than either the Australian or the Shanghai coals, which are landed here for sale to the steamers and to the manufacturers of the islands who use steam power. The cost of the local coal, as compared to the cost of the imported, is, of course, much lower; yet the bad management of the mine mentioned above, such as shutting down for a period when the coal is most wanted, compels the users of coal to depend upon the dealers who handle the foreign coals, for the reason that the latter coals may always be found in stock and ready for delivery.

Future Prospects of Philippine Mines.—It is very evident that if the Americans had never taken possession of the islands that the coal mines would be useless to the country. The few thousands of tons of coals taken from the mines each year were hardly sufficient in importance to cut any figure in the commercial transactions of the islands. There are a great many manufacturing industries distributed over the islands, all of which have been compelled to use wood, cane and other materials under the boilers of the steam plants because of inability to secure coal. These industries include mainly the sugar mills, of which there are dozens in every square mile, all using a boiler to operate the cane crushing machines and to raise the necessary steam for heating liquids, etc. In crossing the islands with a military expedition recently it seemed to me that we met with one of these isolated sugar mills at the rate of two and three in every mile on a straight line. There are a great many woodworking plants springing up under American control, and the owners inform me that, although wood fuel is available, they would prefer coal, if the latter can be obtained at proper prices and without trouble. Then there is considerable shipping touching at all of the principal points in the islands, all of which calls for coal for fuel purposes, and as the local mines have thus far been unable to keep the coal yards filled with coal, such coal as there is on hand is imported, and imported coal is very costly. It is sold in sacks, and the sacks are handled as if they contained precious metals.

There are railroads coming into existence in the islands, and the

Miners Crossing Bamboo Bridge in Philippines.

locomotives have to be changed over for burning wood because of lack of proper supplies of coal. It is just the same in the metal working industries. The steam plants were previously intended to burn coal, but the latter not being obtainable, except at intervals, the proprietors find it best to have the furnaces changed for using wood. There is plenty of wood in the islands, but it is not of course satisfactory for service in all cases of steam raising.

For Gas Works.—There is no doubt if coal could be mined in proper quantities gas works would be established in the islands, for the reason that the expense of oils for illuminating purposes in the Philippines is exceedingly high. Oils for lamps are six times greater in cost than in America. By the time that the oils get transported to the interior, the cost per gallon is so high that only the rich can afford to have a light. I have seen whole barrios of people go to sleep shortly after dark because of not being able to afford a light. Now if it were possible to secure a sufficient supply of coal, there is little doubt that some of the enterprising Americans, who are here at the present time for the special purpose of introducing up-to-date ideas, would undertake to establish gas works. A gas works would pay handsome profits under the circumstances. The coal consumption would be considerable and the mining business assisted.

Coal Tar in Demand.—This is a great country for using vast quantities of coal tar. If gas works were established the consumption of tar in the islands is so great that the proprietors of the gas works would find themselves making considerable money from the sale of the coal

tar. The reason for the call for coal tar is that much of the house building in the Philippines is done by means of split bamboo, and the tar is used to fill in the crevices. Then the shipping is usually built up by means of plaited work in split bamboo, the keel and lower portion of the native craft being solid wood, cut from a tree, while the sides are of this bamboo plaited work, in which the meshes are liberally filled with tar. The coal tar is at present shipped from England, Japan and Russia, and by the time it gets here it is costly. There are practically no paints available, so that the tar is often used as a paint on nipa huts and bamboo houses, for the reason that it makes a good coating and the tar keeps the vermin away. But the cost of the tar prevents its general use. If gas works were established, and the coal tar sold at reasonable rates, the market for it would be very large.

As to Roads.—Of course one of the leading features of mining in the Philippines is the condition of the roads. Your correspondent has been on the go for a year in these islands, and has traversed the roads of nearly all of the southern islands several times over, and found them to be uniformly bad in the wet season and only passable in the dry season. The American soldiers are doing wonders with the roads, however, as wherever the soldiers have established garrisons, they have made it their business to turn out the natives and compel them to grade the roads for miles in all directions. Then the bridges are nearly all down, the insurgents having burned many of them, but by the time this letter reaches the United States, the bridges will in most cases have been replaced; for the department commanders throughout the Philippines have ordered that district commanders see to it that all bridges within their district are rebuilt and the roads made passable for both the wet and dry seasons. The natives are called upon for this work, and hundreds of them are working at each of the crossings rebuilding the bridges. Transportation of the coal to the sea coast or to the markets of the interior can, therefore, be accomplished with practically little more difficulty than under ordinary circumstances in any country. In some of the mines now in operation they are getting the coal to the markets on pack animals, and these animals carry quite a load. In some places they use the caribou and the drag sled. This is the best way whenever the trails through the hills are wide enough for passage. If the trails are narrow, then only pack animals can be used, but even this mode does not overcome the narrow paths around some of the mountains On one occasion I saw a pack horse go over the sides because the bag of coal on the inner side struck the wall of the mountain to the side of the path, causing the horse to lose his balance and go over the side.

Labor.—The cost of labor in this country is so exceedingly small that many of the defects of transportation and machinery are overcome.

The native laborers can be hired for 10 cents per day to work in the mines, and the only sort of shelter they need is a bamboo shack. They will expect to be provided with rice and tuba, costing about 3 cents per day for each man. Coolies can be secured at even a lower rate per day, one new mining company paying only 8 cents per day, and furnishing lodging and food for its laborers. There are plenty of men to work at this price, for the wars are practically over and the soldiery must go to work at something. Then there are the caribou and the native horses to use for purposes of transporting the products of the mine to the coast. These may be purchased outright for about $6 gold each, or can be hired at the rate of about 10 cents per day each. The hours of working are from 6 A.M. to noon, when a 2 hours' rest is taken, and work is then resumed to 6 P.M.

Titles.—Many miners who have undertaken to develop coal and other mines in the Philippines have made the serious mistake of investing their capital in claims not properly adjusted. A year ago it was the custom for prospectors to settle down on any piece of mining property and hold it by force. They often had to shoot interfering natives, and trouble resulted, sometimes in the natives forming, and as a result of the uprising, unless United States troops were near, the miners have been killed. I recollect of several parties attacked in this way. The best method is to first locate the property, and when it is assured that it is worth the working, a visit should be made to the Mining Bureau at Manila, which is controlled and officered by the Government, where the whole history of the property, as recorded by old Spanish land grants, may be secured. All papers relating to lands of all kinds are on record at this office, and when this office assures a miner that such and such a property is free for him to operate upon, or can be purchased from original owners at a stated price, then the miners can return to the lands, establish their rights and no one can interfere. But this habit of settling upon a piece of property, even when the native owner lives within sight in his shack, is a risky piece of business. The natives know no value in their land until they see Americans settle upon it, and begin to take out marketable products. Then they want to drive the prospectors off and work the mines themselves. Bloodshed invariably results, for the reason that, even if the native sells for a small sum of money, some other relative of the native or another claimant of the property will appear. But if the proper papers are secured from the bureau at Manila, the responsibility of ownership rests there, and the miner can refer the native to that office.

The Design of Steam Power Plants.—No. V.[1]

By Mr. Henry C. Meyer, Jr., in *Engineering Record.*

There is occasionally a tendency on the part of some to ridicule elaborate specifications for steam engines, yet as a specification is a description of what one party to a contract agrees to furnish to another, it should be sufficiently complete to define exactly what is to be supplied. A complete specification is unnecessary, perhaps, where an owner engages a builder, without competition, to construct and install an engine suited for existing conditions and agrees to pay for whatever the builder elects to supply. In competitive bidding, the builder is not legally bound to supply anything more than that which the specification calls for, and he is not apt to figure on doing more than that in preparing his bid, knowing full well that other bidders will not do so. Hence, if it is found, after a contract is made, that there are some desirable details which have been overlooked by the engineer in his specification, they must be purchased and paid for as extras, at, naturally, a higher figure than what would cost if specified in the beginning.

The amount of detail necessary in a specification naturally varies with the size of the engine to be purchased, and the extent to which the design departs from the standard types for the service. It is the writer's intention to call attention to a number of details which must be considered in buying a large engine, although reference to them may be omitted in a specification for less important work. The writer believes in specifying the cylinder dimensions, at least in a general way, so that all bidders may bid upon an engine of equal capacity. Methods of determining these dimensions for simple and compound engines of various types were given in the preceding chapter. While they may be fixed by the engineer, some latitude should be given bidders in order that standard patterns may be utilized.

A specification usually begins by stating the type of engine or engines wanted, whether it is to be of the simple, compound or triple-expansion type, whether it is to be run condensing or non-condensing, and where it is to be located. Even though the engineer fixes those dimensions that determine the capacity of the engine, the specification should state the load at which the engine is to operate with the highest economy, the maximum load that it is to be called upon to operate, and the kind of service to which it is to be subjected. If guarantees as to capacity and efficiency are to be required from the builder, these data are, of course, essential. Even if they are not, and the engineer assumes the responsibility for the fulfillment, by the engine, of the requirements imposed by existing conditions, as he does when he fixes the cylinder dimensions, steam pressure and rotative speed, the engine builder should be informed as to what will be required of the engines, as he is very apt to make calculations that will serve as a check on those of the engineer.

Occasionally a specification states that the price of the engine is to include its delivery and erection on a foundation supplied by the owner, and placing it in proper running condition. Usually, however, the engine is sold free on board cars at the railway point nearest the locality where the engine is to be used. Except in special work the builder usually supplies a man to take charge of the erecting of the engine, which is done by labor employed by the owner under direction of the builder's erector.

It is assumed that the engineer has determined the cylinder dimensions, the rotative speed, steam pressure, and whether the engine is to be run condensing or non-condensing; hence the specification should give: Diameter and stroke of cylinders; number of revolutions per minute; horse power to be developed when working at highest efficiency; horse power at maximum load; steam pressure; back pressure if run non-condensing, or vacuum if run condensing.

As before stated, an engineer should not be too rigid in regard to cylinder dimensions, and it is well, particularly when purchasing high speed or medium speed engines, to state in the specifications that engines with cylinder volumes equivalent to those specified will be

1. *Ante*, p. 490.

considered. There are objections to an engine with too short a stroke in proportion to the area of piston; these were stated in the preceding chapter. If the engine is to be run condensing and the builder is to supply the condenser, provision should be made for it.

The engineer should describe in a general way the kind of valve gear that is wanted. If the engine is to be of the compound Corliss type, the automatic cut-off might be applied to one or both cylinders. It is better to have it act on both cylinders if the load is variable, for the reason that a more equal distribution of the load between the cylinders will occur at light loads than there will if the cut-off is applied only to the high pressure cylinder. Again, for Corliss engines, a separate wrist plate for the steam and exhaust valves, each driven by a separate eccentric, may be specified so that the engine may work with a later cut-off and consequently greater overload than is possible if both valves are driven from one eccentric. The cut-off may be applied to both cylinders in other types of compound engines.

If the cylinders are to be steam jacketed in barrels or heads, or both, it should be so stated. Consulting engineers seldom pay much attention to this question, as the value of steam jackets is still a disputed point. Generally, engines for electric service and factory work are not steam jacketed, particularly if the piston speed is over 600 feet per minute. It is the custom in multi-cylinder engines of the medium speed and slow speed types, to place reheating receivers in the steam pipes between the cylinders, in which the steam is heated in transit from one cylinder to the other by live steam admitted to a coil of pipe. The value of these reheaters is also a matter of dispute. However, if they are wanted, they should be specified, also the manner in which the condensation that occurs in them is to be disposed of. The steam passing through the heater from one cylinder to the other is usually at a much lower pressure than the steam in the coils, hence the condensation must be drawn off by separate traps. The connection of these traps with the reheater and with a receptacle into which they can discharge, should be made either by the engine builder or the steam piping contractor.

If the engine is to be of the Corliss type, the kind of bed that is wanted should be mentioned. Two forms are made by most builders, one, known as the heavy duty type, is adapted for heavy work and high pressures, and the other, the girder frame, is lighter and is of older design. The heavy duty design is almost invariably used for pressures over 125 pounds and to an increasing extent in lower pressures; being much stronger, it is a little more expensive. If bids are called for a high rotative speed automatic engine, the specifications should call for an iron sub-base with the engine, for all builders do not furnish them except at extra expense. Occasionally the iron sub-base is not used and the bed of the engine is bolted to a brick foundation which is built up above the floor the height of the sub-base.

There are a number of points concerning the design of the engine, chiefly relating to dimensions of wearing surfaces and the strength of parts, that engineers rarely fix. It is the custom of some, though, to ask each builder what he intends to furnish in respect to certain details, usually about as follows: Diameter and length of bearings, diameter and length of crosshead pins, diameter and length of crank pins, diameter of shaft in the body, dimensions of cross head shoes, length of connecting rod, diameter and face of fly wheel (both may be fixed by the engineer), weight of fly wheel, weight of engine bed, weight of entire engine.

When these data are received from each builder the engineer can tabulate them and compare the proportions of the engines offered. If any part of an engine differs from that of others enough to warrant such a course, the engineer can ask the reason for this deviation, and if it is not a good one the builder can be requested to modify his design, or the bid can be rejected. The engine builder should be asked to furnish a blue print or drawing of some kind showing a plan, an elevation and the principal dimensions of the engine he proposes to furnish.

Regarding details of construction of engines, most American engines are built after standard designs adopted by each builder and not much attention is usually paid in specifications to these details when builders of established reputation are binding. Most builders furnish catalogues containing illustrations of the details of various parts of their engines, such as the valves, valve gear, governor, piston, main bearings, crosshead, etc. If an engineer is obtaining bids on an engine the details of which are unknown to him such illustrations can be asked for. When about to execute a contract with a builder, it can be stated in the contract that the details of construction are to correspond in design with drawings or blue prints or catalogue sketches furnished by the builder.

There are a great many minor details of an engine, such as oil cups, sight feed lubricators, throttle valve, relief valves on the cylinders to prevent them from being damaged by water, cylinder lagging, steam and vacuum gauges, gauge board, provision for attaching the indicators to the cylinders, etc., that have to be looked after, and many builders furnish a printed specification which refers in more or less detail to some of these matters. This specification can be asked for and made part of the contract, but before so doing care should be taken that it does not conflict with the specification issued by the engineer.

The character of materials used in engine construction is not usually given much attention in an engineer's specificatiou, but recently the material of which shafts of large engines are made is receiving more thought, and the kind of metal used, and its treatment, are frequently specified. The most advanced practice is found, probably, in the fluid compressed hollow forged treatment, perfected by the Bethlehem Steel Company. The molten steel is poured into a cylindrical mold and subjected to an enormous pressure while cooling, so as to diminish the blow holes that frequently occur in the ordinary method of casting. The ingot is cooled slowly and the impurities usually collect at its axis; after it has cooled, an axial hole is bored through it to remove these impurities. The ingot is then reheated and a mandrel is slipped through this hole, after which it is forged under a slow moving hydraulic press, the action of which penetrates much more deeply into the metal than is the case with the blow of a steam hammer. After forging, the ingot is annealed to remove internal strains and improve the structure of the metal, which is then machined to size. Sometimes the shaft is oil tempered after annealing. Open hearth and nickel steels are used, the small percentage of nickel added tending to raise the physical properties of the mixture. A large number of recent important engines for mill and electric power house service have been equipped with shafts made in this way.

The time of delivery of an engine should be given in a specification, and with large engines the builder is sometimes required to furnish a man to operate the engine for a short period after it is erected. If the engine room is to be fitted with a traveling crane operated by electricity or by hand, it is well to notify the engine bidders to that effect, as the use of a crane reduces the cost of erecting engines and the owner should have the benefit of this.

In regard to steam piping, the engine builder usually supplies and connects the piping between the cylinders in a compound or triple-expansion engine. In large compound engines, particularly of the cross compound type, that is with the cylinders placed side by side and driving separate cranks, it is frequently the custom to place a valve in the pipe carrying the exhaust steam from the high pressure to the low pressure cylinder, and to run a branch from the high pressure steam pipe to the exhaust pipe and connect with it at a point between the low pressure cylinder and the valve mentioned. With this arrangement the high pressure cylinder can be cut out, and the engine driven by the low pressure side alone. The pipe conveying high pressure steam to the low pressure cylinder is usually provided with a pressure reducing valve as well as an ordinary stop valve. By connecting the exhaust from the high pressure cylinder at a point between that cylinder and the stop valve between the two cylinders, with the main exhaust pipe, and by placing a valve in the exhaust from the low pressure cylinder, the low pressure cylinder can be entirely cut out and the engine driven by the high pressure cylinder. The advantage of such an arrangement in the event of the breakdown of one side of the engine is obvious.

For electric work, where revolving parts of dynamos are mounted on the engine shaft, as is the custom in directly connected work, the specifications should require the engine builder to cut a keyway in the shaft. The dynamo builder usually supplies a key for keying the armature of the dynamos on the engine shaft. The dynamo and engine are sometimes shipped by their respective builders to the site of the power plant and the engine or the dynamo builder fits the armature to the shaft. In other instances the armature of the dynamo is shipped to the engine builder and is put on the shaft by the latter. The specification should state what the engine builder is to do in this respect.

A specification often asks what steam consumption the builder of an engine will guarantee. If a guarantee as to steam consumption is to be made, it should be of the following general form: "The engine is guaranteed to consume not more than ——— pounds of steam per indicated horse power per hour when developing ——— horse power when running at a speed of ——— revolutions per minute with a steam pressure of —— pounds above the atmosphere, and with a back pressure of ———pound above the atmosphere." If the engine is to run con-

densing instead of with a back pressure above the atmosphere the vacuum to be carried should be stated. The usual vacuum is 26 inches of mercury. If the engine is provided with steam jackets and reheating receivers, it should be stated that the steam used by them is to be included in the consumption of the engine. If the engine is to run condensing, the steam used by the air pump should be included. Sometimes, when condensers are not supplied by the engine builder, the steam used by the air pump is not considered as being part of the steam used by the engine. If the air pump steam is or is not to be considered as part of the engine consumption, a statement to that effect should appear in the guarantee.

A fair guarantee to ask concerning the regulation is that the speed of the engine shall not vary more than 1½ per cent. on either side of the normal speed under any condition of load. The builder should guarantee the workmanship and materials to be of the best, and agree to make good at his expense any defects in the engine, not due to neglect, that develop during the first year it is in operation.

The Ethics of Insulating Materials.

By Mr. J. Wright, in *Electrical Review*.

It is not my intention here to discourse upon insulating materials in general, but rather to confine my remarks to a consideration of those substances, chief amongst which are india-rubber and gutta-percha, so largely employed for the insulation of electric cables and wires.

The growing scarcity of the above-mentioned commodities recently led to a short general article in a contemporary from the pen of Mr. Terry, an authority of note on the subject, in which the writer comments upon the various substitutes for rubber and gutta-percha which have been introduced to a greater or less extent during the past few years.

It is not by any means so easy a task as would appear at first sight to obtain a satisfactory substitute for rubber and gutta-percha in the insulation of cables. It must be remembered that flexibility, combined with mechanical strength, and resistance to the passage of electric currents of varying tension, disruptive or otherwise, to say nothing of absence of porosity and durability under extremely variable climatic conditions, are but few of the many essential properties which must be possessed in the requisite degree by the substitute. India-rubber, or caoutchouc, as we all know, is a gum obtained from the sap found in the middle layers of the bark of certain trees indigenous to South America, Africa and the East Indies. It exudes on an incision being made in the bark for the purpose, and is collected by the natives of the locality in various ways. The main object aimed at, however, whatever be the manner in which it is undertaken, is to procure the coagulation of the rubber by exposing it in thin layers to the smoke of a wood fire fed with a species of nut also indigenous to the locality, and collected for the purpose.

If this drying be not properly effected, the rubber retains a certain compound which acts as a form of solvent and destroys it. This destructive agent is always present in a greater or lesser degree, and shows its presence in rubber which has been exposed to the atmosphere for a lengthened period, by converting it into a treacly mass contained by an outer oxidized crust which is extremely brittle.

The best, or Para rubber, when freshly procured, is extremely elastic, and has a generous modicum of "life," but, unfortunately, it is impossible to employ it in this condition for insulating purposes, as the impurities which all samples contain necessitate a somewhat severe course of washing and mastication in powerful machines specially designed for the purpose, which treatment decreases its vitality in a marked degree, but, at the same time, renders it, in the form of sheet or strip, of such consistency as to be suitable for applying to the cable.

Pure Para is too expensive to employ alone as an efficient insulating coat, and it is, therefore, applied as a single thin layer, supplemented by a layer or layers of compound rubber which consist of an admixture of pure rubber with certain other ingredients, such as french chalk, sulphur, naphtha (as a solvent), etc., with which, by a due series of apportioning the quality and nature of the resultant rubber compound are toned, so to speak, to the pitch required in practice. The resultant rubber, as may be expected, is in the form of a workable mass, not unlike thick putty in the majority of cases, and in this state is applied to the cable or wire in the form of strips.

Now, there are two methods of applying rubber strip to a cable. One, the slower and more expensive method, is by lapping it spirally, two adjacent layers being lapped in opposite directions in order to absorb the joint and render the coating homogeneous. The other method, and the one more generally adopted, is by longitudinal compression. Two strips of rubber are applied to the cable, one above and the other below, and are compressed together at the sides in the form of a seam, by their passage with the cable between a pair of hard steel rolls revolving in contact, and semi-circularly grooved to the finished diameter of the covered cable. The seam thus made is an efficient one, and depends on a peculiar property possessed by rubber to a marked degree, viz., cohesion. If two freshly cut rubber surfaces be brought into immediate contact, they will cohere and form as homogeneous a mass as the uncut remainder.

Mr. Terry in his article especially refers to the seam in rubber covered cables, and, I think, rather inclines to regard it as a weak point, but if proper precautions be taken for the exclusion of dirt and moisture, and the covering rolls be accurately turned so as to form a complete circle, there is no danger of weakness.

The subsequent process consists in spirally lapping the cable with a strong canvas tape to resist expansion and its subsequent valcanization by exposure to steam pressure at a stated temperature for a certain period. This latter process imparts elasticity and durability to the compound by a combination of sulphur, which is one of the ingredients.

By the judicious apportioning of the ingredients in the rubber compound, and by varying the thickness of the primary coating of pure rubber, the insulation resistance per mile of the finished cable is controlled, and in this manner any result from a few megohms to several thousand may be obtained. The subsequent results are, of course, slightly variable, *i. e.*, they do not resolve themselves into round figures, but an approximation to the required result is easily obtained by experiment. It is also possible to vary the subsequent insulation resistance by the degree of vulcanization, for the longer a rubber compound is vulcanized up to a certain point, the higher will be its immediate insulation resistance. Such treatment, however, beyond the recognized time limit is extremely injurious, as it shortens the "life" of the cable by artificially aging it; it is a trick resorted to nevertheless by unscrupulous manufacturers to bring their cables up to the specified insulation.

In the earlier days of rubber insulated cables it was a recognized thing for engineers and others to specify high insulation resistances, and insist on having them, a custom which has, however, led to an investment in wisdom at the expense of the purchaser. With rubber, as with gutta-percha, it is not "initial meghoms per mile" which are required as much as durability, low electrostatic capacity, and resistance to disruptive discharge.

I have as yet touched but lightly upon the vulcanization process, which is based upon one of the most important properties of rubber, viz., that of combining chemically with sulphur when under steam pressure at temperatures varying from 250° to 350° F. The action is purely a chemical one, and the rubber, after the process, assumes an elasticity and durability which it did not possess in its raw mixed condition; moreover, the longitudinal seam due to manufacture, is rendered homogeneous by it, and is, in fact, difficult to localize after vulcanization. It is important to blend with the other ingredients just sufficient sulphur, and no more, than the rubber will take up, as, otherwise, a certain quantity of sulphur will be left free, and will, by its presence, tend to corrode the copper conductor. For this reason the latter is tinned, and in many cases what is known as a "separator" or layer of rubber with little or no sulphur in its constitution is introduced between the primary layer of pure, and the outer one of compound rubber, with the object of absorbing any excess of sulphur not taken up by the latter.

With a good quality, properly vulcanized, rubber covered cable or wire one can do almost anything, short of willfully damaging the rubber coat. It will stand bending round its own diameter, and, indeed, very severe handling, before deleterious effects will be observed.

Gutta-percha, also an expensive material for insulating purposes, is not suitable for electric light and power work, where an appreciable rise of temperature in the metallic conductors themselves is at times unavoidable, owing to its susceptibility to variations of temperature. It is, however, admirably adapted for sub-marine telegraph cables, and also for telegraph and telephone wires laid underground. When new, it has a very light tint, but ages rapidly with exposure to air, darkening in color, owing to the formation of a crust of oxide on its outer surface, which becomes very brittle. The best conditions for its maintenance are to place it under water having a fairly even temperature of from 40° to 80° F. This prevents oxidation, and it will last under these conditions for years.

For underground work it is usually covered with a strong spiral canvas tape saturated with Stockholm tar, from which, however, the

natural acids have previously been extracted. This latter is an important point. Such a covering has a similar preservative effect to the foregoing immersion in water, and it prevents ingress of air, and, in a moist atmosphere, at a fairly even temperature, answers very well.

The well-known Callender cables are insulated with a substance known as "bitite," which consists essentially of purified vulcanized bitumen. They are very suitable for low pressure town mains and feeders where they are not likely to be disturbed, and, for such purpose, are usually laid in troughs filled up solid with a bituminous compound. For general work, however, they will not stand the manipulation that rubber insulated cables are capable of withstanding.

Fiber cables, another substitute for rubber, are certainly cheaper, but they have many disadvantages, which, to a certain extent, annul any advantages due to a low prime cost. They consist mainly of a fibrous material, such as hemp, loosely wrapped round the conductor, and impregnated with suitable insulating compounds, such as bitumen, etc., and subsequently sheathed with lead to exclude moisture. Their disadvantages are numerous; in the first instance, fibrous materials are hygroscopic, and require to be well heated to expel any moisture which they may contain before being lead sheathed. This heating tends to destroy the fiber. Then, again, air, although a splendid insulator when in a dry state, is unable to withstand disruptive discharges of electricity and it is practically impossible to manufacture a fiber cable and guarantee the insulating material absolutely free from air, as the latter is readily retained in the form of minute bubbles, which, when the cable is subjected to a high e.m.f., speedily assert their existence by the breaking down of the insulation at that point. Finally, these cables absolutely depend for their insulating qualities on the total exclusion of moisture, and a pinhole in the lead sheathing, although not discernible under the initial tests, means the subsequent development of a fault. Pure lead also, if placed directly in the ground, is very subject to corrosion, although a slight alloy of tin decreases the risk in this respect.

To pass on to paper insulation. As far as telephone work is concerned, paper has evidently come to stay. As an insulating material it is light, cheap in prime cost, and—most important point of all—its specific inductive capacity is extremely low compared with other materials, all of which render it an admirable insulator for underground multiple wire telephone cables. Such cables have been largely adopted by the National Telephone Company, the paper being packed quite loosely around the wires in the lead sheathing, and, in conjunction with their system of passing a continuous current of dry air through the containing sheath, have proved highly satisfactory.

For electric light and power, paper insulated cables, as manufactured by the British Insulated Wire Company, of Prescot, for instance, are subject to the same disadvantages as fiber cables, but withal, are of comparatively low prime cost and are eminently suitable for low pressure mains and feeders, as well as with a greater thickness of dielectric for high pressures.

Summing up the various materials in vogue for cable insulation today, what is urgently required is a substance which, while possessing the durability, elasticity and imperviousness of rubber, shall be cheap, and yield good results electrically, *i. e.*, it must possess a low specific inductive capacity, and a high specific resistance, under all ordinary conditions, and above all, be capable of easy application to the wire or cable which it is intended to insulate.

Such a substance is not at present on the market, but a fortune awaits the lucky individual who discovers and patents such a compound.

Trials and Troubles of Instituting and Enforcing Municipal Inspection and Control.

[A paper read by MR. M. G. CANFIELD, Supt. Police and Fire and Municipal Inspection, Grand Rapids, Mich., at the Pittsburg Convention of the Society of International Municipal Electricians.]

The topic assigned to me for this meeting is one that is always before us. It is not possible for us to give too much time and careful study to the many and varied conditions that are continually presenting themselves. The rapid strides made in electrical work in the last 8 or 10 years—especially construction methods, not alone in material, but in the way of doing the work—are far greater than in any other branch of business. It is, therefore, necessary for us, if we expect to succeed in our profession, to devote a great deal of time and some money to fitting ourselves to keep pace with the new applications of old methods and a great many new ones that are developed from time to time.

In commencing municipal inspection, the city council passes an ordinance to give legal authority to the person designated to promulgate a set of rules and regulations that will protect all interests alike; and to my mind there is no set of rules that covers this work as well as the national electrical code as far as it goes, but it does not go far enough for our purposes. We are as much interested in the safety and protection to life as we are to property, and for this reason it is necessary for us to formulate rules to regulate what may be termed outside work, so that with ordinary precaution the lives of linemen, firemen and others are protected as much as possible.

There is another matter that is worthy of considerable thought by municipal inspectors, and that is, who shall and who shall not do electrical work on his own responsibility. It should not be the desire of anyone to place obstacles in the way of a man to earn an honest dollar when he can; neither is it good policy to allow school boys and a floating element that is always with us (except when we want to find them) to do electrical construction. As a remedy for this evil I am very much in favor of making it necessary for a company or person doing electrical work to be licensed and give a bond of say, $1,000, to protect the license. There should be no fee attached to the license to make it a hardship for a competent man to earn a living, and there is no question but what any competent and respectable man could obtain two sureties on a bond to protect a license. If this policy is carried out, much time will be saved by the inspector.

We now arrive at a period when the inspector starts out to do business. And before speaking of his difficulties, I wish to say a few words in regard to him.

The nature of his work makes it a necessity for him to examine the work of all alike. It is not to be expected that he is infallible; but if he is honest in his opinions and makes a report of the exact conditions as he sees them—and the competent inspector does not take anybody's word, but sees for himself—when he does this there is no one to find fault with him except people who want to do work and use material that they know, or at least should know, would not make good construction.

We all know it is is impossible to compile and have printed a set of rules that will always apply to some particular work or some conditions that will very materially change the fittings, wires and the way the work should be done. Municipal inspection, like almost all city improvements, meets its greatest opposition during the first year of its existence. I do not mean to say that the time will ever come when we will not meet with people who will say they have a right to have their work done as they want it, regardless of any city ordinance. We meet people very often who would sit up late nights to protest against a powder mill being installed and operated next door to their store or residence, but these same people very often think that we are interfering with their private business if we tell them they cannot run weatherproof wire on the joist between the floor and ceiling so that rats or moisture will form a short circuit and set fire to their buildings, and generally at a time when there is no person around to put it out.

One of the most difficult things to handle, especially during the first year of the ordinance, is to have old equipments remodeled to increase the safety of the equipment against fire and accident, and by the change the consumer saves many dollars from wasted current caused by leakage.

One of the first things people will say when you speak about substituting porcelain knobs for wood cleats, and many other things just as bad is, "Why, we have used that for ten years or more, and we never had any trouble with it."

It would be taking too much time to dwell on this matter, but I cannot refrain from giving one example. The place was a large (for our town) store. A high potential arc circuit that furnished light in several blocks, both inside and outside lights. In this particular store there were six lights in different parts of the store and the wire for the store was No. 8 cotton magnet wire, held to the ceiling by a strip of soft pine moulding. I was informed by the manager of the store that they had used that same equipment for 12 years and never had any trouble with it. I informed him that 16 years ago, when I commenced electric light work, that kind of construction was all right because we did not know better; but we have learned by experience that the construction methods of those days were unsafe and dangerous and have gone by, wood, fuse, blocks and all, never to come back.

One of the best object lessons for a man that says his old equipment is all right, is to show him a single pole, 75-ampere fuse block that we use to-day, and at the same time one that was used very generally 15 years ago, and your change of equipment follows very soon.

I do not favor the idea of a municipal inspector posing as a bureau of information, but he should give a lucid reason for what he asks to have done.

To control these matters as they occur from day to day, we cannot pay too much attention to the many details connected with it. When a ruling is made on some form of construction, a copy of the same should be placed on file in the office, for reference, so that one contractor cannot say that you favor one more than another. The inspector should have a record of the number of times he goes to see each equipment, and the date of each visit, together with a summary of the condition of the installation—in fact, the ideal office should be able to furnish any information desired in reference to the condition of any equipment in the city in about five minutes.

Some Recent Work on the Diffusion of Gases and Liquids.

In a paper read before the last meeting of the British Association by Horace T. Brown, F.R.S., the author noted that his recent work, in conjunction with Mr. F. Escombe, on the fixation of carbon by green plants from the carbon dioxide of the atmosphere, necessitated a re examination of the process of *static diffusion* from a somewhat new standpoint, and in the course of the experiments some new and interesting facts were brought to light which have an important bearing on the laws of diffusion of gases and liquids.

In the case of carbon dioxide and air the absolute rate of the interpenetration of one gas by the other has hitherto only been determined for high ratios of mixture, but it would be manifestly unsafe to apply the values of such coefficients to the static diffusion of atmospheric carbon dioxide, which only exists in the air to the extent of 0.03 per cent. by volume. An attempt was consequently made to determine the co efficient of diffusivity of atmospheric carbon dioxide by a process of static diffusiou.

If we imagine a vertical cylinder to be filled with atmospheric air containing the normal amount of carbon dioxide, and regard any plane surface within the enclosed air, it follows, from the kinetic theory, that in any given time the same average number of carbon dioxide molecules will cross this plane in opposite directions, and there will conse quently be no change in the average distribution of the molecules throughout the cylinder. If, however, we imagine the bottom of the cylinder to become suddenly capable of absorbing carbon dioxide, say by the introduction of a layer of a solution of caustic alkali, then the molecules of this gas which strike the bottom of the cylinder will be wholly or partially trapped, and in the first brief interval of time a very thin stratum of air, parallel to and immediately above the absorbing surface, will be partially depleted of its carbon dioxide. If we now further consider the interchange of carbon dioxide molecules taking place between this partially depleted layer and the one above it, it is evident that now in a given interval of time a larger number of the molecules must pass from the higher to the lower stratum than from the lower to the higher; the "balance of exchange" will consequently be in favor of the lower layer. This is a condition which will be rapidly propagated from below upwards, and, providing the air outside the cylinder is maintained of uniform composition, a *static condition* will be established in the column. When this condition has been reached, the uncompensated balance of exchange between any two contiguous layers will constitute a steady *flux* or *drift* of carbon dioxide from the outer air to the absorbent surface, the rate of which, if the surface is perfectly absorbent, will be conditioned solely by the diffusitivity of the gas. The question from the mathematical standpoint can now be treated in exactly the same manner as the "flow" of heat in a bar after the permanent state has been reached, or the "flow" of electricity between any two regions of a conductor maintained at a constant difference of potential.

The diffusitivity of atmospheric carbon dioxide has been determined on these lines by the author and Mr. Escombe, and has been found to have a mean value in C.G.S. units of 0.137. It is pointed out, however, that the difficulties of eliminating all disturbing causes are very great, but that the experiments suffice to show that the inter-diffusitivity of carbon dioxide and air in the ratio of mixture in which they occur in the atmosphere does not materially depart from the value obtained by Loschmidt and others with much higher ratios of mixture. Another and more accurate method subsequently described confirms this conclusion.

An account is then given of the author's researches on the diffusion of gases and liquids through apertures in a diaphragm.

If a condition of static flow of atmospheric carbon dioxide is established down a short column of air, towards a perfectly absorbent surface, the rapidity of flow, conditioned by the diffusitivity of the gas, is strictly proportional to the area of the cross section of the column. If, however, we partially obstruct the open end of the column with a diaphragm pierced with a single central aperture, or if we introduce such a diaphragm anywhere in the line of flow, diffusion is modified in a remarkable and unexpected manner.

As the aperture in the septum is gradually reduced in size, the flow through unit area is accelerated, and when the rim around the hole has a breadth of two or three times the diameter of the aperture, this acceleration is found to vary inversely as the diameters of the opening. In other words, the amount of flow then becomes directly proportional to the *linear dimensions* of the opening.

The same fact was also shown to hold good for the diffusitivity of aqueous vapor in air, either by the static diffusion of the vapor down a column of air, or by the evaporation from dishes which were covered by thin plates of mica perforated with holes of a definite size. The "diameter law" was also proved for diffusible salts in solution in a somewhat similar manner, the mobility of the liquid being destroyed by using a small percentage of gelatine.

When a solution of caustic alkali is exposed to air which is in slight motion, the amount of carbon dioxide absorbed in a given time is proportional to the *areas* of the surface exposed; but if the liquid surface is surrounded with a broad rim in the same plane, and precautions are taken to prevent air currents, it is then found that absorption takes place proportionately more rapidly with the small disks of liquid. When extreme precautions are taken, and comparatively small surfaces are employed, a very near approach to the "diameter law" can be attained, but it is more difficult to obtain this result with plane absorbent surfaces than it is with apertures in a septum, for reasons which will be seen later.

The explanation of the phenomena so far described is as follows:

If we consider the simple case of a circular disk of liquid, surrounded by a broad rim and capable of absorbing carbon dioxide, when such a disk is exposed to perfectly still air, the convergent lines of carbon dioxide will creep through the air towards the disk, establishing a steady gradient of density, and this creep will be a flux perpendicular to the lines of equal density, which will thus form curved surfaces or "shells" surrounding the disk and terminating in the rim. The case is analagous to that of an *electric field* in the neighborhood of a conductor, having the same shape and dimensions as the absorbent disk. The curves or "shells' of the gas of equal density are the analogues of the similarly curved lines of *equipotential* above the surface of the electrified disk, while the converging lines of creep or flux of the gas are the analogues of the *lines or tubes of force*. The partial pressure of the carbon dioxide in the shells of equal density must vary from *zero* at the absorbent surface to a density corresponding to the maximum pressure of the carbon dioxide in the atmosphere, a point which is theoretically at an infinite distance, but which is practically reached at a distance of five or six times the diameter of the disk. From these considerations it follows that the gradient of density, on which the diffusive flow depends, must vary inversely as the diameters of the disks, and that the absorbing power of the disks will vary directly with their linear dimensions, a deduction which is completely verified by experiment.

In the case of a diffusive flow through a circular aperture in a diaphragm, the hyperbolic lines of flow, which are *convergent* as they approach the aperture, bend round their foci situated in its edges, and from a *divergent* system on the other side. On the inner side of the diaphragm there is produced a system of density shells similar to those outside, but with the gradient of density in the contrary direction. This system of shells is termed *negative*, and is as effective as the outer *positive* system in regulating the flow according to the diameter law, so that this law still holds good even if the outer air currents are sufficient to sweep away the external positive shells completely. This fact explains why it is easier to obtain a demonstration of the "diameter law" by diffusion through apertures than by diffusion into an absorptive disk formed by a solution of caustic alkali.

By diffusing coloring matter through apertures in a diaphragm the "density shells" can be rendered visible, and it may be shown that their ellipsoidal form is exactly that which is demanded by the above hypothesis.

Simple mathematical expressions were given for all the possible cases of diffusion through apertures in thin plates, and in plates of a sufficient thickness to constitute tubes.

Diffusion through multi-perforate diaphragms was next considered,

the septa employed being thin celluloid plates pierced with small circular holes of a determinate diameter.

Such septa produce a local disturbance and intensification of the gradient of density in their immediate neighborhood, so that the velocity of the flux increases as the obstruction is reached, and decreases again when this is passed. The result of this is that it is found possible to perforate a thin plate with a series of very small holes in such a manner as to exercise but little obstruction when it is interposed in a line of diffusive flow, although the aggregate area of the small holes may represent only a small fraction of the total area of the septum.

Examples were given, and also formula for the calculation of the amount of resistance produced by a septum of a given thickness and perforated with holes of a definite size and distribution. The diffusive flow observed experimentally under these conditions is in close accord with that demanded by theory.

This method of diffusion through apertures affords a new and apparently accurate method of determining *coefficients of diffusitivity*. The author and Mr. Escombe have, up to the present time, applied it to the cases of atmospheric carbon dioxide, aqueous vapor, and solutions of sodium chloride.

Electric Furnaces.

In a paper read before the International Electricity Congress, Paris, by M. Keller the author took as archetypes of all modern electric furnaces those of Siemens and Huntingdon and Moissan. The first of these consisted of a crucible of some refractory earth, receiving current at its base, a movable carbon pencil fixed within it acting as the second electrode. The arc was thus formed between the lower point of this carbon electrode and the surface of the materials contained within the crucible. The Moissan furnace consisted of a block of lime, hollowed out at its center to receive the materials to be heated, and provided with horizontal channels for reception of the two carbon pencils conveying the current. A second block of lime, fitting over the first, completed this furnace, and served to retain the heat emitted by the arc which formed between the points of the two carbon pencils, when the electric current was passed along them. The materials in this furnace were placed in the hollow cavity in the centre of the block, and the arc played *over* their surface.

The first of the electric furnaces developed from the above laboratory types for industrial purposes was that of the brothers Cowles. In this furnace the material to be treated was placed between two conducting surfaces, which conveyed the current, and was surrounded by non-conducting finely divided material. The current was thus obliged to traverse the material lying between the two electrodes, and if this in the unfused state was a non conductor of electricity, movable carbon electrodes were used in order to form an arc above the furnace contents, and bring them to the fused condition. This furnace, invented in 1885, and improved in 1887, was used at Milton in Staffordshire for reduction of aluminum oxide, and for production of aluminum alloys.

The Héroult furnace introduced at a later date for obtaining alloys of aluminum with copper, was based upon the same principle as that of the Cowles brothers. This furnace has been used at Froges at Neuhausen for production of aluminum, and more recently for the production of calcium carbide. The modified form adopted for the latter manufacture consists of a box mounted upon wheels, the base of which is of carbon, and the sides of some non-conducting material. The base of this box acts as one electrode, and a carbon rod, subject to a vertical up and down movement, forms the second. The furnace body is thus movable, and can be wheeled away when the reaction is completed, in order to be replaced by a newly charged one.

The author next classifies the furnaces designed for calcium carbide manufacture as: (1) Arc furnaces (based on the Moissan and Siemens type); (2) Resistance furnaces (based on the Héroult type); (3) Incandescence furnaces (based on the Cowles type).

Arc furnaces may be again subdivided into three classes, according to the mobility of one or both electrodes and the number of carbons used. The furnaces designed by Patin, by the Deutsche Gold und Silberscheide Anstalt, and by Street, have both electrodes movable, and thus come under subdivision I.

A very large number of furnaces fall into the second group, having one electrode fixed—generally as hearth or floor of the furnace. The furnaces exhibited by the Société des Carbures Métalliques at the Exhibition, and those designed by Siemens and Halske, Schuckert, and other well known firms for carbide production, are of this type.

To the third subdivision belong all forms of the multiple arc furnace, which has lately become much used, because it enables the area of arc heating to be greatly extended. The Gin and Leleux, Bertolus, Memmo, Nicolai, and Bovy furnaces are leading examples of this type. In most of these furnaces the floor of the furnace acts as the secondary electrode for the arcs which form between it and the three or more primary electrodes fixed around it. Polyphase currents are generally used with these furnaces.

In all arc furnaces the temperature attained varies with the intensity of the current used, but as in any case the temperature of the arc is very high, and considerably above that required, loss of energy follows from arc heating in carbide production. There is also considerable loss of material, owing to the finer material charged being carried away by the "blowing" of the furnace. For these and other reasons arc furnaces are not suitable for carbide production.

Resistance furnaces resemble in form and construction arc furnaces, but they work with a lower e.m.f., as the materials charged into the furnace body act as intermediate conductor between the two terminal carbons. The work done can be calculated by aid of the Joule formula $W = RI^2$, and the temperature attained is directly related to the sectional area of the electrodes. In this type of furnace the fusion of the materials is tranquil, and is unaccompanied by violent evolutions of gas.

For carbide production an e.m.f. of 20 volts to 25 volts suffices, but heavier currents are requisite than with the arc furnaces, and conductors of larger sectional area must therefore be provided. The new furnace of the Compagnie Electrométallurgique des Procédés Gin and Leleux is of this type, and is employed in a large number of carbide works.

In the third class of furnace—incandescent furnaces—the intermediate conductor between the ends of the two electrodes is formed by a succession of small pieces of coke or other form of carbon. The passage of the current causes this bed of coke to attain a high temperature, and the materials placed upon it or mixed with it in their turn are raised to the same temperature. This type of furnace permits the utilization within a limited area of the greatest amount of energy, and avoids the grave defect of the second type, namely, that the currents must always traverse the whole depth of the layer of materials already fused.

The author then passes on to consider electric furnaces under another classification, namely, that of the kind of current employed. Furnaces using continuous current have been sometimes called electrolytic furnaces, because in these not only thermal but chemical effects may be produced. Alternating current furnaces have laterly been widely adopted, because the dynamos yielding monophase or polyphase currents are better adapted to stand the resistance variations incidental to electric furnace operations.

The furnaces employing monophase currents are best arranged in series, for in this case it is possible to utilize a higher e.m.f. and to save copper in the necessary leads. If, however, arc heating is being employed, it is better to connect the furnaces in parallel.

Bertolus, in 1897, was one of the first to patent the application of polyphase currents to furnace work. In the furnace designed by Bertolus triphase current was used, and three carbon electrodes were connected to the three terminals of the dynamo, while the hearth of the furnace itself provided the common return electrode. In later forms, the three different phases of the current have been utilized in separate furnaces, and these therefore each operate as though worked with monophase current.

Electrodes.—The difficulty of obtaining carbon electrodes of suitable size and length has for a long time hindered the increase of the size of the furnaces. Engineers have, however, given much attention to this question, which for the carbide industry is of considerable economic importance.

For those furnaces in which vertical electrodes are used, the carbon is generally formed square or rectangular in section, and undergoes special treatment in order to increase its conductivity, while for the other types of furnace carbons are usually made round.

In order to protect the carbon at the point where it entered the furnace, it was at one time customary to use water for cooling purposes, but this proved dangerous, and it has been given up for cold air, or some form of protecting composition.

Regulating the Electric Current.—In the modern forms of furnace for carbide production, working with relatively low e.m.f., it is usual to find currents of 8,000 amperes to 10,000 amperes employed.

With such currents it is impossible to use ordinary cut-outs, and it is customary to make the movable electrode of the furnace act as circuit breaker. On account of the accidents which may occur to the dynamo, steam engine, or turbine, when a single furnace is worked in this manner on an electric circuit, it is advisable to work several furnaces in parallel from the one dynamo.

Current Pressure.—The e.m.f. required in arc furnaces varies greatly, and depends upon the conductivity of the gases which are emitted from the heated substances. In the manufacture of carbide of calcium, an e.m.f. of 50 volts to 60 volts is required, in that of corundum 50 volts suffices, while the electro thermal method for production of iron only requires 20 volts.

In resistance furnaces a lower e.m.f. is generally sufficient, and carbide of calcium can be manufactured in the Héroult type of furnace with a current of only 25 volts pressure. Aluminum can be produced in the same furnace with a pressure of from 20 volts to 25 volts.

The third type of furnace, "incandescence furnace," can work with practically any e.m.f. up to 80 volts or 100 volts, for the resistance increases with the increase of the length of the bed of materials through which the current has to pass, and this may be varied at will.

Current.—In the Cowles type of furnace currents of 5,000 amperes at 50 volts to 60 volts have been used. In the Héroult furnace currents of 6,000 amperes are used. For carbide production it is more customary to use currents of from 1,000 amperes to 2,500 amperes with single pairs of electrodes, but where several pairs of electrodes are used for arc heating in the same furnace, this current may be doubled, trebled, or quadrupled. Furnaces with a single arc, and one movable electrode arc, however, now being worked with currents of 5,000 amperes to 6,000 amperes. The Gin and Leleux type of resistance furnace can be worked with currents up to 10,000 amperes, and the same amount of current can be utilized in the incandescence furnace, which, working with a higher e.m.f. than the resistance furnace, is able to utilize for thermal purposes no less than 1,000 kw. electrical energy.

Developments of the Electric Furnace Industry.—Recent estimates have placed the total energy employed in electric furnace operations at 230,000-horse power, of which total, calcium carbide accounts for 185,000-horse power, aluminum for 27,000-horse power, copper for 11,000-horse power, and carborundum for 2,000 horse power. In France alone it is estimated that 60,000-horse power are employed in the carbide manufacture; while the production of phosphorus, vanadium, and ferro-chromium are more recent thermo-chemical industries started in Savoy.

The improvements made in electric furnaces in recent years have resulted in a greatly improved output of carbide per kilowatt hour, and in the latest form of the Gin and Leleux furnace it is now possible to obtain 6.20 kg. carbide per kilowatt day of 24 hours. This corresponds to a thermal efficiency of 75 per cent.

The paper closes with a few details concerning the electric furnaces which are exhibited in the electro-chemical section of the Paris Exhibition. Three of these are shown in operation, and comprise a Moissan furnace, a Bullier furnace, and a small model of the Gin and Leleux type of furnace. The first consumes 40 kw., and the second and third 70 kw. electrical energy when in operation.

The editor of *The Electrician*, from which this abstract is quoted, adds in criticism of the paper: "M. Keller, being a Frenchman, naturally claims for Moissan an important place in connection with the development of the electric furnace, but we think he is incorrect in putting forward the Moissan laboratory furnace as a type from which forms now in use for industrial purposes have been derived. Moissan carried out his most valuable and classical laboratory researches upon high temperature reactions in the years 1893 and 1894, and it is only just to point out that Siemens had devised and experimented with an electric arc furnace 15 years earlier—namely, in 1878-79—and that the Cowles furnace was used upon an industrial scale in America in 1885, and in this country one year later. These two furnaces, the Siemens and the Cowles, are, therefore, the original types upon which all later forms of arc and resistance furnaces have been based. M. Keller, in pressing Moissan's claims to be the inventor of a furnace which others have copied and turned to industrial uses, is therefore claiming for the latter a position which we are disposed to think the noted French chemist would hardly claim for himself."

MR. HENRY ROCHAT has been appointed Superintendent of the Ashland Light, Power and Street Railway Company, of Ashland, Wis.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES

IN accordance with the formal agreement of some time ago, between the authorities and the proprietors of the Paterson and Passaic (N. J.) Gas and Electric Company, the net rate of $1.10 per 1,000 cubic feet ($1.25 gross) for the district supplied goes into effect November 1st.

THE 1,000 shares of new stock in the Consumers Gas Company, of Toronto, Ont., which were sold at public auction by Messrs. C. J. Townsend & Co., the morning of the 12th inst., realized the handsome average price of 215¼.

THE proprietors of the Waukegan (Ills.) Gas Light and Fuel Company have secured the necessary right of way to continue their system of gas distribution from Waukegan to Highland Park.

THE executive management of the Decatur (Ills.) Gas and Electric Light Company, as completed early this month, is: President, J. Manchester Haynes; Vice-President, W. B. McKinley; Secretary, W. C. Johns.

SECTIONS 3 and 4 of the ordinance governing the grant, approved by Chief Burgess Lewis on the 4th inst., for the operation, in Steelton, Pa., of the Steelton Home Gas Company, are: "The privileges conferred are granted to said Company, upon condition that said Company shall sell gas at a rate not to exceed $1 60 per 1,000 cubic feet for illuminating gas, and $1 30 per 1,000 cubic feet for fuel gas, with a discount thereon to the consumer of 15 cents per 1,000 cubic feet for prompt payment, and the further condition that the net price per 1,000 cubic feet to be charged for gas is not to be in excess of the average price obtained in other cities of approximately the same population in the State of Pennsylvania, east of Johnstown. The said Company shall, if requested so to do, furnish gas for lighting purposes, free, for the Council Chamber, the offices of the School Board and Chief Burgess, and the pumping station."

AT the first annual meeting of the River Shore Gas Company, of Riverton, N. J., the officers chosen were: President, John C. S. Davis; Vice-President, James Hartley; Treasurer, Howard Parry; Secretary, J. Otto Thilow.

EX-SENATOR JAMES SMITH, JR., is said to have declined to accept the Presidency of the Essex and Hudson Gas Company, of Newark, N. J., which post has been vacant since the death of the Company's first President, B. M. Shanley. It is likely that the place will go to Mr. John F. Shanley, who is a brother-in-law of ex-Senator Smith.

THE proprietors of the Portland (Ore.) Gas Company report that the immediate result of the reduction of the gas rate there has been a surprising increase in output. The increase is mainly in respect of the output on gas range account, which statement, however, is not to be taken as meaning that the illuminating account gain is unimportant.

THE gas division of the Waltham (Mass.) Company's plant is now entirely under the charge of Mr. H. H. Kelley. The electrical division of the Company is in control of Mr. Walter Stearns, vice Mr. F. A. G. Hill, resigned.

MAX A. BAUM, formerly Superintendent of the Meridian (Miss.) Gas Light Company, died suddenly at Florence, Ala., the morning of the 11th inst.

THE North Adams (Mass.) Gas Light Company has applied to the Board of Gas and Electric Light Commissioners for permission to increase its capital stock in the sum of $50,000. A hearing on the petition will be held the morning of the 23d inst. The purpose of the increase is to provide funds for an addition to the plant.

THE Municipal Light Board of Wakefield, Mass., who direct the affairs of the Municipal Light Plant of Wakefield, have applied to the Board of Gas and Electric Light Commissioners for the necessary permission to supply gas in the adjoining district of Stoneham.

ON November 6th the electors of Tyrone will be called upon to vote for or against the following, entitled, "An ordinance to provide for the purchasing of the works and property of the Tyrone Gas and Water Company by the Borough of Tyrone, as provided by the laws of the Commonwealth of Pennsylvania, for the purpose of supplying said Borough and its inhabitants with gas and water, and providing for obtaining the assent of the electors of the Borough of Tyrone at the next general election to an increase of the Borough indebtedness for

that purpose." The amount agreed upon for the taking over of the named plants is $100,000.

AT a quarterly meeting of the Milford (Mass.) Board of Trade, Messrs. Louis B. Magid, H. E. Morgan and Patrick H. Gillon were appointed a committee to confer with the State Board of Gas and Electric Light Commissioners with a view to causing a reduction in the selling rate charged by the Milford Gas Light Company.

THE Southbridge (Mass.) Gas and Electric Company's business for the past half year warranted the declaration of a 2½ per cent. dividend.

WE are informed that the Federal Gas and Fuel Company, of Columbus, Ohio, has begun to supply natural gas in that city.

A CORRESPONDENT in San Mateo, Cal., writes us that the electric plant of the Leland Stanford, Jr., University will shortly be closed down, a contract having been made with the Consolidated Light and Power Company, whereby the latter is to supply all the current required for light and power. At present the University's need in these respects calls for current for 5,000 incandescent lamps and 75-horse power in motors.

THE proprietors of the Santa Rosa (Cal.) Lighting Company have announced a reduction in the selling rates. Hereafter a supply on lighting account will be charged for at $2.50 per 1,000 cubic feet; on fuel and power account, $2 per 1,000. This is equivalent to a concession of 50 cents per 1,000 on each account.

THE authorities of Lemoore, Cal., have ordained that "Every person, firm, or corporation manufacturing and supplying to the public, gas, electricity or other materials for artificial light, shall pay a license of $2 per quarter; but the license hereby does not include a franchise to such person, firm or corporation to erect poles or wires or to lay pipes in the streets and alleys of the city."

THE business offices of the La Porte (Ind) Gas and Coke Company are to be removed to the Meyer building, corner of Monroe and Jefferson streets.

THE plant of the Noblesville (Ind.) Gas and Improvement Company has been purchased by a syndicate headed by Mr. B. G. Dawes, of Marietta, O., and Mr. C. R. Heath, of Muncie, Ind.

THE Kewanee (Ills.) Light and Power Company is constructing a new gasholder. Important main extensions are also being made.

THE Boston *Evening Journal* says that Parker C. Chandler, counsel for the Bay State Gas Company, of Delaware, has filed a motion in the United States Circuit Court, asking the Court to allow the Bay State Company to become a party to the various suits entered against the Boston Gas Light, Bay State, of Massachusetts, Roxbury and South Boston Gas Companies and the Massachusetts Pipe Line Company. The significance of this move is found in a recent act of the Massachusetts Pipe Line Company, which has filed a motion asking the Court to have plaintiff amend his bill of complaint by striking out the section in which he claims beneficial ownership in 4,994 shares of the capital stock of the Boston Gas Light Company, which is deposited with the Mercantile Loan and Trust Company, of New York, as security for the stock of the Bay State Company of New Jersey. The Massachusetts Pipe Line Company contends that Addicks must stand and be regarded as the actual owner of one share of that stock, and as not having a so-called beneficial ownership in 4,994 shares. The Company claims that there is no proof offered that he actually has any such beneficial ownership and that the Court cannot regard him in any such light. In order to offset this, Parker C. Chandler asks that the Bay State Gas Company, of Delaware, be allowed to intervene. If this is allowed by the Court, there will be two petitioners—J. E. Addicks and the Bay State Company, of Delaware. The Bay State Company will be able to claim the beneficial ownership as well as an ownership in the other Companies in the suits. The question of whether or not the Court will issue the injunction preventing the consummation of the contracts by which the different Companies agreed to purchase gas from the Massachusetts Pipe Line Company will have to remain in abeyance for a long time. Hearings are now being held before Hon. Charles Almy, in the course of which both sides are to present their case. They will not be completed before next spring, and a report by the Examiner will not be in the hands of the Court before next spring.

MR. ROBERT W. ELLIOT, Vice-President and General Manager of the Hudson County (N. J.) Gas Company, says that the high price of anthracite coal has wonderfully stimulated the sale and use of gas ranges, in the Company's Hoboken district especially.

THE Boston *News Bureau* is authority for the statement that the New England Gas and Coke Company is sending out substantially the following quantities of gas per day to the named Companies:

Company.	Quantity.
Brookline	2,250,000 cubic feet.
Jamaica Plain	200,000 "
Dorchester	800,000 "
Boston	1,500,000 "
Dedham and Hyde Park	40,000 "

THE itinerant gas meter inspecting concern of McCauley, May & Co., at last advices was back in Detroit, doing the best that its members know in their line. A correspondent, writing from that city, under date of the 12th inst., notes that recently the members of the firm entered into a contract with H. W. Rickel, a local maltster of some importance, to inspect on his premises one gas meter and two water meters, the pay for the job to be $20. The inspector's return to Rickel was: One water meter correct; one water meter 7 per cent. slow; the gas meter, 2 per cent. fast—within the limit of the State law. When the bill was presented, the maltster asserted that the meter testers were frauds, refused to settle, and notified the Police Department. The question is, why did not Rickel notify the police when the testers called; and many answer it by replying that he looked for different results, plus rather than equal or minus, for instance. Our correspondent adds: "There is little to fear by the local Gas Company on account of a most rigid inspection of its meters in use."

MR. J. GIBBONS, JR., we are told, will remain permanently in charge as Superintendent of the properties of the Pine Bluff (Ark.) Water and Light Company.

THE contention of the politicians who officially rule Texas at the present time, seemingly is that vested interests have rights merely on blackmailing account. Knowing that their acreage is large in their counties, they evidently believe that the population of their cities may be safely counted on to yield tribute in money to them as the acre yields corn or cotton to the farmer, when atmospheric conditions are favorable to the latter's working. In time the political blackmailers of the cities of Texas will possibly learn that their blackmailings have put Eastern capital to flight; in fact, it looks that that lesson has been read to them, especially in the instance of those who, under authority of the right from civil power, would establish gas or electric light and water supply plants in places now without such service, and which would be without them for years if that ministering were left to the "push" of home capital. Texas in fact is a State that will and should be shunned by investors who would help it and themselves by giving to it that which it will not protect. This paragraph is prompted by the past developments in the gas situation at San Antonio and by the going developments in like lines at San Antonio.

THE flash-in the pan gas rate war in Chicago is settled. Gas wars in these days of low selling rates are not so protracted as when the figures per 1,000 cubic feet were "pretty well over a dollar."

Engineering Record says that the cost of electric light and power to consumers in Tönsberg, Norway, where a gas driven plant using gas generated on the Dowson plan was completed in December, 1898, is as follows: Meters are provided at an annual rental ranging from $3.37 for fifteen 16 candle power lamps to $8.08 for 200 lamps. The hourly charge for lighting is 13 47 cents per kilowatt, and for power 3.23 cents per kilowatt. At this price the cost per hour for incandescent lamps ranges from 0.26 cent for 5 candle power to 1.29 cents for 32 candle power; and for arc lamps burning in pairs, from 2.93 cents for each lamp of 200 candle power and 3 amperes up to 5.92 cents for each lamp of 1,000 candle power and 8 amperes; and for power 2.42 cents per horse power hour. The total cost of the plant (which, to indicate its size, had two 45 horse power gas engines) was about $25,000; of this, the gas works cost 12½ per cent. and the engines and dynamos, 30.2 per cent. The plant was described by Mr. Einar Rasmussen in "Teknisk Ugeblad."

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO., PROPRIETORS.

THOS. J. CUNNINGHAM, ELBERT P. CALLENDER, EDITORS.

CHAS. E. SANDERSON, MANAGER.

PUBLISHED ON EACH MONDAY OF THE YEAR AT No. 32 Pine Street, New York.

The JOURNAL is the official organ of the
NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
AMERICAN GAS LIGHT ASSOCIATION.
WESTERN GAS ASSOCIATION.
OHIO GAS LIGHT ASSOCIATION.
PACIFIC COAST GAS ASSOCIATION.

TERMS:

SUBSCRIPTION—Three Dollars per annum, in advance. Single copies, 10 Cents.

Notification Respecting Advertising.—Orders for new advertising, or for changes in standing advertisements, to insure attention in the issue following their reception, must be in hand any time of Wednesday.

AGENTS:

New York—American News Co. 39 and 41 Chambers St.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime Street, London.

MONDAY, OCTOBER 22, 1900.

The Market for Gas Securities.

Brisk trading was done during the week in the local gas share market, and considerably higher prices were recorded. Consolidated sold up to 177 to-day (Friday), and the close was made at 177 to 177½. Nothing of interest in connection with the gas situation cropped out to account for the increasing Stock Exchange values, so the gain must be attributed to the buoyancy of the general market.

Brooklyn Union is nominally 165 to 175, with next to nothing doing in it on actual trading account. Next month will see that apathy at an end. Peoples, of Chicago, scored a sharp advance on the ending of the rate war. Bay State was traded in, with the high mark in it of 1⅛. Baltimore Consolidated is the same as last week. Lacledes are steady, and some inquiry cropped out for the bonds. Consumers, of Toronto, issued some new stock recently. It was sold at auction, and the average price obtained for it was 215½. Gas bonds continue in good demand.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

OCTOBER 22.

☞ All communications will receive particular attention. ☜ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$4,595,200	100	177	177¼
Central Union, Bonds, 5's	3,000,000	1,000	106	107½
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	120	..
Metropolitan Bonds	658,000	.	108	112
Mutual	2,500,000	100	208	205
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	.	..	.
New Amsterdam Gas Co. Bonds, 5's	11,000,000	1,000	105	105¼
Northern Union, Bonds, 5's	1,250,000	1,000	102	103
New York and East River Bonds 1st 5's	3,500,000	1,000	103	106⅜
" 1st Con. 5's	1,500,000	..	115	.
Richmond Co., S. I.	548,650	50	70	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	132	136
Preferred	5,000,000	100	149	152
Bonds, 1st Mortgage, 5's	1,500,000	1,000	114	114
Yonkers	299,610	500	180	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	170	175
" " Bonds (5's)	15 000,000	1,000	116	119
Bay State	50,000,000	50	1⅛	1⅜
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works	450,000	100	25	28
" 1st Mtg. 5's	475,000	1,000	96⅞	99⅛
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	..	4½
" " Bonds, 5's	5,250,000	1,000	63	65
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Central San Francisco	2,000,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati G. & C. Co.	8,500,000	100	196½	198
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,207,000	1,000	106	107
Columbus (O.) Gas Lt. & Heating Co	1,662,750	100	60	65
Preferred	3,026,500	100	84	86
Consumers, Jersey City Bonds	600,000	1,000	102	105
Consumers, Toronto	1,700,000	50	215	216
Consolidated, Baltimore	11,000,000	100	53½	54
Mortgage, 6's	3,500,000	..	..	113
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,400 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	12	14
" Con. Mtg. 5's	380,000	1,000	80	85
Consolidated G. & E. Co.'s., Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co	4,500,000	50	95	97
" Prior Lien 5's	4,598,000	1,000	99¼	100
Detroit Gas Co., 5's	386,000	1,000	100	101
" Inc. 5's	16,000	100	94	94½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	35	40
Fort Wayne	2,000,000	..	35	41
" Bonds	2,000,000	..	60	64
Grand Rapids Gas Lt. Co.	1,000,000	50	105	107
" 1st Mtg. 5's	1,125,000	1,000	..	..
Hartford	750,000	25	..	230
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	72	83
" Bonds, 6's	2 650,000	..	98	100
Jackson Gas Co.	250,000	50	70	75
" 1st Mtg. 5's	250,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	101½	103
Laclede, St. Louis	7,500,000	100	68½	68¾
Preferred	2,500,000	100	97	100
Bonds	10,000,000	1,000	107	107½
Lafayette Gas Co., Ind.	1,000,000	100	35	40
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	110	120
Madison Gas & Elec. Co.	400,000	100	68	75
" 1st Mtg. 6's	350,000	1,000	102½	108
Montreal, Canada	2,000,000	100	183	184⅜
Newark, N. J., Con. Gas Co	6,000,000	..	..	55
Bonds, 6's	4,600,000	..	..	103
New Haven	1,000,000	25	280	300
Nashville Gas Lt. Co.	1,000,000	50	110	..
Oakland, Cal.	2,000,000	..	46	47
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	93	93⅛
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	90¾	91
2d "	2,500,000	1,000	104	105
Rochester Gas & Elec. Co.	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	47¼	47½
St. Paul Gas Light Co.	1,500,000	100	46	49
1st Mortgage 6's	650,000	1,000	82	85
Extension, 6's	600,000	1,000	..	..
General Mortgage, 5's	2,428,000	1,000	88	90¾
St. Joseph Gas Co.	1,000,000	100	30	35
" 1st Mtg. 5's	750,000	1,000	96¾	98
Syracuse, N. Y.	1,750,000	100	..	11
Bonds	1,612 000	1,000	88¼	93
Washington, D. C	2,000,000	20	206	207
First mortgage 6's	600,000	..	..	..
Western, Milwaukee	4,000,000	100	90	91
Bonds, 5's	3,880,500	.	107	107½
Wilmington, Del.	600,000	50	200	201

Advertisers' Index.

GAS ENGINEERS.

	Page
Wm. Henry White, New York City	675
Fred. Bredel, Milwaukee, Wis.	662
Geo. R. Rowland, New York City	673
The Western Gas Construction Co., Fort Wayne, Ind.	680
Humphreys & Glasgow, New York City	673
American Gas Co., Phila., Pa.	662
David Leavitt Hough, New York City	672
Economical Gas Apparatus Construct'n Co., Toronto, Ont.	659
Baxter & Young, Detroit, Mich.	672
United Gas Improvement Co., Phila., Pa.	667
James T. Lynn, Detroit, Mich.	672
A. E. Boardman, Brevard, N. C.	672

GAS WORKS APPARATUS AND CONSTRUCTION.

Continental Iron Works, Brooklyn, N. Y.	674
Deily & Fowler, Phila., Pa.	676
Kerr Murray Mfg. Co., Fort Wayne, Ind	672
Stacey Mfg. Co., Cincinnati, Ohio	675
Bartlett, Hayward & Co., Baltimore, Md.	673
Davis and Farnum Mfg. Co., Waltham, Mass.	672
R. D. Wood & Co., Phila., Pa.	674
Isbell-Porter Company, New York City	674
Fred. Bredel, Milwaukee, Wis.	662
United Gas Improvement Co., Phila., Pa.	667
National Gas and Water Co., Chicago, Ills	669
Economical Gas Apparatus Construct'n Co., Toronto, Ont.	659
The Western Gas Construction Co., Fort Wayne, Ind.	680
Humphreys & Glasgow, New York City	673
American Gas Co., Phila., Pa.	662
Logan Iron Works, Brooklyn, N. Y.	676
Riter-Conley Mfg. Co., Pittsburgh, Pa.	675
Baxter & Young, Detroit, Mich.	672
American Bridge Co., New York City	668
G. Shepard Page's Sons, New York City	672
James T. Lynn, Detroit, Mich.	672
A. E. Boardman, Brevard, N. C.	672
Sutherland Construction & Improvement Co., N.Y. City	669
Chris. Cunningham & Son, Brooklyn, N.Y.	664

PROCESSES.

Bartlett, Hayward & Co., Baltimore, Md.	673
United Gas Improvement Co., Phila., Pa.	667
Burdett Loomis, Hartford, Conn.	674
National Gas and Water Co., Chicago, Ills.	669
Economical Gas Apparatus Construct'n Co., Toronto, Ont.	659
The Western Gas Construction Co., Fort Wayne, Ind.	680
Humphreys & Glasgow, New York City	673
Sutherland Construction & Improvement Co., N.Y. City	669
B. E. Chollar, St. Louis, Mo.	658

SCRUBBERS AND CONDENSERS.

R. D. Wood & Co., Phila., Pa.	674
Continental Iron Works, Brooklyn, N. Y.	674
Logan Iron Works, Brooklyn, N. Y.	676
Riter-Conley Mfg. Co., Pittsburgh, Pa.	675

TAR AND CARBONIC ACID EXTRACTOR.

R. D. Wood & Co., Phila., Pa.	674

AMMONIA CONCENTRATORS.

Michigan Ammonia Works, Detroit, Mich.	656
American Gas Company, Phila., Pa.	662

GAS METERS.

John J. Griffin & Co., Phila., Pa.	640
American Meter Co., New York and Philadelphia	679
Helme & McIlhenny, Phila., Pa.	679
D. McDonald & Co., Albany, N.Y.	677
Nathaniel Tufts Meter Co., Boston, Mass.	678
Maryland Meter and Mfg. Co., Baltimore, Md.	678
Metric Metal Co., Erie, Pa	679
Keystone Meter Co., Royersford, Pa.	678
Detroit Meter Company, Detroit, Mich.	679

PREPAYMENT METERS.

American Meter Co., New York and Philadelphia	679
John J. Griffin & Co., Phila., Pa.	640
D. McDonald & Co., Albany, N. Y.	677
Helme & McIlhenny, Phila., Pa.	679
Nathaniel Tufts Meter Co., Boston, Mass.	678

GAS AND WATER PIPES.

M. J. Drummond & Co., New York City	664
R. D. Wood & Co., Phila., Pa.	674
Warren Foundry and Machine Co., New York City	664
Donaldson Iron Co., Emaus, Pa.	664
Chris. Cunningham & Son, Brooklyn, N.Y.	664
Cornell & Underhill, New York City	664
Charles Millar & Son Co., Utica, N. Y.	664

GAS MAIN STOPPERS.

Safety Gas Main Stopper Co., N. Y. City	661

GAS TAPPING MACHINES.

George Light, Dayton, O.	657
H. Mueller Manufacturing Company, Decatur, Ills.	657

FLEXIBLE JOINTS.
Campbell Mfg. Co., Stamford, Conn 656

STEAM BLOWER FOR BURNING BREEZE.
H. E. Parson, Brooklyn, N. Y. 660

GAS COALS.
Penn Gas Coal 671
Perkins & Co., New York City 670
Despard Gas Coal Co., Baltimore, Md. 671
Westmoreland Coal Co., Phila., Pa. 671
Berwind-White Coal Mining Co., New York and Phila. ... 670

CANNEL COALS.
Perkins & Co., New York City 670
Greasy Creek Cannel Coal and Tramway Co., Chicago .. 656

CONVEYORS.
The Link-Belt Machinery Co., Chicago, Ills. 661

GAS ENRICHERS.
Standard Oil Co., New York City 671
The Sun Oil Co., Pittsburgh, Pa. 673

COKE CRUSHER.
C. M. Keller, Columbus, Ind. 671

GAS GAUGES.
The Bristol Co., Waterbury, Conn. 661

GAS GOVERNORS.
Connelly Iron Sponge and Governor Co., New York City 669
Isbell-Porter Co., New York City 674
R. D. Wood & Co., Phila., Pa. 674
Wm. M. Crane Co., New York City 657

CEMENTS.
C. L. Gerould, Galesburg, Ills 668

RETORTS AND FIREBRICKS.
J. H. Gautier & Co., Jersey City, N. J. 668
Adam Weber, New York City 668
Laclede Firebrick Mfg. Co., St. Louis, Mo. 668
Cyrus Borgner, Phila., Pa. 668
James Gardner, Jr., Co., Pittsburgh, Pa. 668
Henry Maurer & Son, New York City 668
Baltimore Retort and Firebrick Co., Baltimore, Md. 668
Parker-Russell Mining and Mfg. Co., St. Louis, Mo. 668
Brooklyn Firebrick Works, Brooklyn, N. Y. 668
Missouri Firebrick Co., St. Louis, Mo 668

REGENERATIVE FURNACES.
Bartlett, Hayward & Co., Baltimore, Md. 673
Fred. Bredel, Milwaukee, Wis. 662
J. H. Gautier & Co., Jersey City, N. J. 668
Parker-Russell Mining and Mfg. Co., St. Louis, Mo. 668
Adam Weber, New York City 668
Missouri Firebrick Co., St. Louis, Mo. 668

SELF-SEALING MOUTHPIECE DOORS.
Isbell-Porter Co., New York City 674
Continental Iron Works, Brooklyn, N. Y. 674
Logan Iron Works, Brooklyn, N. Y. 676
R. D. Wood & Co., Phila., Pa. 674

INCANDESCENT GAS LAMPS.
Welsbach Company, Gloucester, N. J. 666
Kern Incandescent Gas Light Co., New York City 660

BURNERS.
C. A. Gefrorer, Phila., Pa. 674
Wm. M. Crane Co., New York City 661
D. M. Steward Mfg. Co., Chattanooga, Tenn. 661

LAVA GAS TIPS.
D. M. Steward Mfg. Co., Chattanooga, Tenn. 661

STREET LAMPS.
Welsbach Street Lighting Co., New York and Phila. 666
Thos T. W. Miner, New York City 657

PURIFIERS.
Stacey Mfg. Co., Cincinnati, O. 658

PURIFYING MATERIALS.
Connelly Iron Sponge and Governor Co., New York City 669

VALVES.
Ludlow Valve Manufacturing Co., Troy, N. Y. 661
Chapman Valve Manufacturing Co., Boston, Mass. 661
R. D. Wood & Co., Phila., Pa. 674
Continental Iron Works, Brooklyn, N. Y. 674
The P. H. & F. M. Roots Co., Connersville, Ind. 663
Isbell-Porter Co., New York City 674
The Western Gas Construction Co., Fort Wayne Ind. 680
Kerr Murray Mfg. Co., Fort Wayne, Ind. 672

EXHAUSTERS.
The P. H. & F. M. Roots Co., Connersville, Ind. 663
Isbell-Porter Company, New York City 674
Connelly Iron Sponge and Governor Co., New York City 669
Kerr Murray Mfg. Co., Fort Wayne, Ind. 672

ELECTRICAL APPARATUS.
Wm. Henry White, New York City 675

ENGINES AND BOILERS.
The Hazelton Boiler Company, New York City 657

PURIFIER SCREENS.
John Cabot, New York City 661

GAS STOVES.
American Meter Co., New York and Philadelphia 665
Maryland Meter and Manufacturing Co., Baltimore, Md. 678
Keystone Meter Co., Royersford, Pa. 678
Nathaniel Tufts Meter Co., Boston Mass. 678
Wm. M. Crane Co., New York City 657

HOT WATER HEATERS.
Wm. M. Crane Co., New York City 657

GASHOLDER TANKS.
J. P. Whittier, Brooklyn, N. Y. 673

GASHOLDERS.
Bartlett, Hayward & Co., Baltimore, Md. 673
Continental Iron Works, Brooklyn, N. Y. 674
Deily & Fowler, Philadelphia, Pa. 676
Davis & Farnum Mfg. Co., Waltham, Mass. 672
Kerr Murray Mfg. Co., Fort Wayne, Ind. 672
Stacey Mfg. Co., Cincinnati, Ohio 675
R. D. Wood & Co., Philadelphia, Pa. 674
Logan Iron Works, Brooklyn, N. Y. 676
Riter-Conley Mfg. Co., Pittsburgh, Pa. 675

STORAGE TANKS.
Chris. Cunningham & Son, Brooklyn, N. Y. 664

GAS SECURITIES.
Henry Marquand & Co., New York City 676

ADVERTISING.
J. Howland Harding, New York City 656

BOOKS, ETC.
Newbigging's Handbook 677
Field's Analysis, 1899 676
Scientific Books 670
Digest of Gas Cases 671
Practical Photometry 224
Gas Flow Computers 678
Hughes' "Gas Works" 669
Gas Engineer's Pocket-Book 224
Excerpts from Reports of Gas Commissioners 669
Binders 664
Directory of Gas Companies 675
Practical Handbook on Gas Engines 677
Coal Tar Tree 658
Poole on Fuels 356

WANTED,
A GAS MAKER

Who understands how to run Lowe machine; also, rebricking, etc. Salary, $30 per month. Address,

ASHLAND LIGHT. POWER & STREET RAILWAY CO.,
1324-1

WANTED,
A GAS MAKER

Who thoroughly understands how to operate Lowe water gas apparatus—double superheater type. Applicant must give satisfactory references, and name places where he has been employed. Address "G. M.,"
1323-2 Care this Journal.

WANTED,
A Competent Man to Superintend a Small Gas Plant

In Southern city. Must understand manufacture and distribution, including the laying of services. Correspondence solicited. Address, "PRESIDENT,"
1323-3 Care this Journal.

FOR SALE.
A 6-Inch Connelly Automatic Street Governor.

Address C. M. KELLER,
1320-tf Columbus, Ind.

FOR SALE,
A New Condenser and Scrubber,

Each 11 feet 6 inches high, 3 feet in diameter, inside measurement, and 6-inch connections—all connections reinforced. Two manholes to scrubber, with two sets of trays; also one 6-inch center valve. These have never been used.

Address PEEKSKILL GAS LIGHT COMPANY,
1300-tf Peekskill, N. Y.

For Sale.
A Small Gas and Electric Light Plant,

in a Southern city of 3,800 inhabitants.

Address FORT WAYNE ELECTRIC CORPORATION,
1097-tf Fort Wayne, Ind.

PROPOSALS FOR GASHOLDER.

Bids will be received by the Clinton Gas Light and Coke Company, of Clinton, Ia., until November 1st, 1900, for the erection of a telescopic gasholder. Inner section, 80 feet diameter; outer section, 82 feet diameter; each section 20 feet 6 inches deep. Diameter of tank, 84 feet 6 inches. Inner section must weigh enough to give a pressure of 5 inches of water,

Work to be completed by July 1st, 1901.
1321-5

Flexible Joints for All Purposes.

Steam, Gas, etc. Seventy-five per cent cheaper than hose to convey steam to holder cups. It is a packed joint, and when repacked is as good as new. Have been in use on a number of holders for years. *Catalogue free.*

CAMPBELL MANUFACTURING CO.,
Box 271. Stamford, Conn.

Utilize Your Gas Liquor.
NO EXTRA LABOR OR OPERATING EXPENSES.

Ammonia Concentrator.

Not Expensive. Write to
STROH & OSIUS, Pat'ees, or
Mich. Ammonia Works, Detroit, Mich.

PLANS ADVICE WRITING ILLUSTRATING
J. HOWLAND HARDING,
ADVERTISING,
1545 BROADWAY, LONG ACRE SQUARE
NEW YORK

HENRY MARQUAND & CO.,
BANKERS
AND
BROKERS.

160 Broadway, New York City.

KENTUCKY CANNEL COAL, FOR GAS AND DOMESTIC USE.

GEO. R. HISLOP, F.C.S., F.R.S.S.A., Gas Engineer of Paisley, Scotland, says in his analysis: "This is a remarkably rich Cannel Coal, yielding illuminating matter per ton equivalent to 1,945 lbs. of sperm candles."

This coal mined and shipped in box cars. Write for sample car and delivered price.

The Greasy Creek Cannel Coal and Tramway Co.,
163 WEST WASHINGTON STREET, CHICAGO, ILLS.

The "Omega" Odorless Sanitary Gas Stove.

Unique in design and made on scientific principles. The flame, from specially designed Bunsen burner, plays up against a plate, forcing heat current down and out. Air current superheated before reaching burner, assisting combustion and destroying injurious products by intense heat.

Fitted with special atmospheric burners, requiring no flue connections. Saves 50 per cent. in fuel. Uses natural or artificial gas. Utensil holder at top.

MADE IN TWO SIZES.

FINISHED IN BERLIN BLACK, ALUMINUM and ANTIQUE COPPER.

FULL LINE OF GAS APPLIANCES.

Manufactured by

William M. Crane Company,

1131-1133 Broadway, New York.

FOUNDRY: PEEKSKILL, N. Y.

We have our own Pattern Shop, Foundry and Factory.

"THE MINER"

Globe Street and Boulevard Lamps.

Cheapest and Best.

THOUSANDS IN USE WITH INCANDESCENT BURNERS.

Send for Catalogues.

THOMAS T. W. MINER,

821-823 Eagle Av., N.Y.

GAS TAPPING MACHINES

—FOR—

Drilling and Tapping Pipe under Pressure

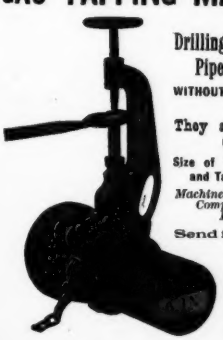
WITHOUT ANY ESCAPE OF GAS.

They are Strong and Compact.

Size of Combination Drills and Taps ¾ to 4-inch.

Machines Sent to any Gas Company for Thirty Days' Trial.

Send for Circulars.



Geo. Light,

DAYTON, O.

MUELLER

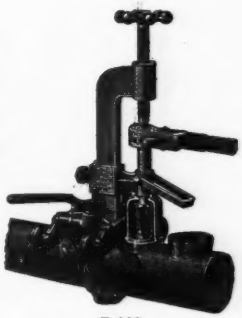
SPECIAL ATTACHMENT GAS TAPPING MACHINE.

By the use of this attachment to our regular pattern machine your service men are exempt from danger of asphyxia, can make more taps a day, and need less help.

CATALOGUES FROM

H. MUELLER MFG. COMPANY,

DECATUR, ILLS.



B-109.

Hazelton Water Tube Boilers.

HIGH PRESSURE.

The Pioneer Vertical Water-Tube Boiler of the World.

Over 11½ Square Feet of Heating Surface per Horse Power.

High Quality and Durability of the Tubes the Most Vital Part of a Boiler.

Fastened at One End Only, Expand and Contract Without Strain, Averting any Possibility of Leakage.

Boilers we Built have been in Constant Use 18 Years, and are in Operation To-day with Fine Results.

10 to 25 Per Cent. Guaranteed Over Other Boilers.

Strong, Natural, Upright Draft, Consuming All Kinds of Fuel. Absolutely Dry Steam.

Small Floor Space, Less per Horse Power than for Any Other Boiler.

The **HAZELTON BOILER CO.**

SOLE PROPRIETORS AND MANUFACTURERS,

120 Liberty St., N.Y. Telephone, 4124 Cortlandt

Cable Address, "Pails," N. Y.

AMERICAN BRIDGE CO.,

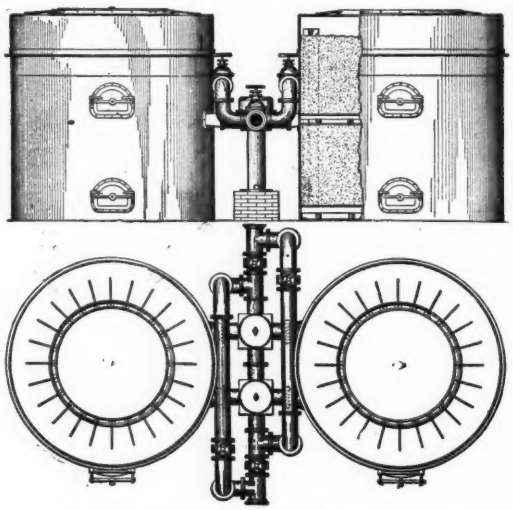
GENERAL OFFICES:
No. 100 Broadway, New York City.

Designers and Builders of all Classes of Metallic Structures.

WE have decided to carry at all our plants a large stock of Raw Material, from which we can furnish with great promptness any ordinary order for Steel Bridges, Roofs, Buildings, Columns, Girders, Beams, Channels, Angles, Plates, etc.

BRANCH OFFICES AND WORKS:

Albany, N. Y.,	Chicago, Ills.,	Groton, N. Y.,	Pencoyd, Pa.,	Salt Lake City, Utah,
Athens, Pa.,	Canton, O.,	Horseheads, N. Y.,	Philadelphia, Pa.,	Sidney, N. S. W.,
Boston, Mass.,	Cleveland, O.,	Lafayette, Ind.,	Pittsburg, Pa.,	Trenton, N. J.,
Buffalo, N. Y.,	Denver, Col.,	Milwaukee, Wis.,	Rochester, N. Y.,	Wilmington, Del.,
Baltimore, Md.,	Duluth, Minn.,	Minneapolis, Minn.,	Seattle, Wash.,	Youngstown, O.,
Butte, Mont.,	East Berlin, Conn.,	New Orleans, La.,	San Francisco, Cal.,	London, England.
Columbus, O.,	Elmira, N.Y.,			



CHOLLAR'S SYSTEM OF GAS PURIFICATION.

Covered by Five U.S. Patents.

In operation, revivification of the oxide is effected by repeated reversals of the direction of the flow of the gas through the beds (in the two boxes used under this system there are eight different routes for the gas to take) whereby the purified gas is made to revive the oxide in parts of the apparatus while the foul gas is fouling it in others.

The boxes are charged or discharged from the sides as well as the top.

There are no Hydraulic Cups or heavy covers.

Either end of the apparatus is inlet or outlet at pleasure.

The capacity is increased five-fold or more over ordinary methods without addition to building.

The apparatus costs less than for any other system.

For Estimates Write **The Stacey Mfg. Co.,**
SOLE MANUFACTURERS,
FOR FURTHER INFORMATION WRITE **CINCINNATI, OHIO.**
B. E. CHOLLAR, 411 N. 11th St., St. Louis, Mo.

Coal Tar Genealogical Tree.

Mr. T. Viner Clarke, of London, Eng., having compiled a novel Chart or Map illustrating the various CHEMICAL PRODUCTS DERIVED FROM COAL AND COAL TAR, in the form of a Genealogical Tree, including all the products discovered (the total number amounting to near 700), offers for sale a limited number of copies in Colors, mounted on Linen, with Rollers. Price, $3.50. Orders may be sent to

A. M. CALLENDER & CO., No. 32 Pine Street, New York.

W. H. PEARSON, Prest. W. H. PEARSON, Jr., Vice-President. J. T. WESTCOTT, M.E., Manager. L. L. MERRIFIELD, M.Inst.M.E., Chief Engineer.

THE ECONOMICAL GAS APPARATUS CONSTRUCTION CO., LD.

American Offices: 269 FRONT STREET, EAST, TORONTO, ONT.
London Offices: 19 ABINGDON STREET, WESTMINSTER, S.W.

Telegraphic Address: "CARBURETED LONDON AND TORONTO."

The above Company have erected since 1893, or are now erecting, their universal type of Carbureted Water Gas Plants at the following Gas Works:

	Cubic Feet Daily.
Blackburn, England	1,250,000
Windsor Street Works, Birmingham, England	2,000,000
Saltley Works, Birmingham, England	2,000,000
Colchester, England	300,000
Birkenhead, England	2,250,000
Swindon (New Swindon Gas Company), England	120,000
Saltley Works, Birmingham, England (Second Contract)	2,000,000
Windsor Street Works, Birmingham, England (Second Contract)	2,000,000
Halifax, England	1,000,000
Toronto	250,000
Ottawa	250,000
Toronto (Second Contract, Remodeled)	2,000,000
Lindsay (Remodeled)	125,000
Belleville	250,000
Ottawa (Second Contract)	250,000
Brantford (Remodeled)	200,000
St. Catherine's (Remodeled)	250,000
Kingston, Pa.	125,000
Montreal	500,000
Peterborough, Ont.	250,000
Wilkesbarre, Pa.	750,000
St. Catherine's (Second Contract)	250,000
Buffalo, N. Y.	2,000,000
Winnipeg, Man.	500,000
Colchester, England (Second Contract)	300,000
York, England	750,000
Rochester, England	500,000
Kingston, Ont.	300,000
Crystal Palace District, England	2,000,000
Duluth, Minn.	300,000
Caterham, England	150,000
Enschede, Holland	150,000
Leicester, England	2,000,000
Buenos Ayres (River Platte Co.)	700,000
Burnley, England	1,500,000
Kingston-on-Thames, England	1,750,000
Accrington, England	500,000
Tonbridge, England	300,000
Stretford, England	500,000
Oldbury, England	300,000
Saltley Works, Birmingham, England (Third Contract)	2,000,000
York, England (Second Contract)	750,000
Rochester, England (Second Contract)	500,000
Newport, Monmouth, England	250,000
Todmorden, England	500,000
Tokio, Japan	1,000,000
Nelson, British Columbia (Complete Gas Works).	

Sutherland Construction & Improvement Co.

Offices: 15 WALL ST., NEW YORK, and OSHKOSH, WISCONSIN.

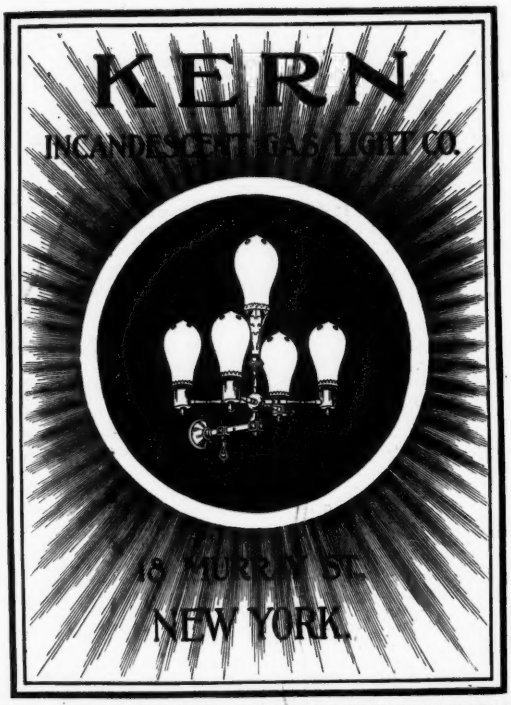
Owners of the "SUTHERLAND" Patents for Water Gas Apparatus.

Gas, Electric Light, Water Works, and Electric Street Railways Built, Remodeled, Operated, Bought and Sold.

A few of the places where the SUTHERLAND Apparatus is in successful operation:

Ilion, N. Y.
Herkimer, N. Y., 2 orders.
Little Falls, N. Y.
Fishkill-on-Hudson, 2 orders.
Clifton Springs, N.Y., 2 orders.
Green Bay, Wis.
Stevens Point, Wis.
Tarrytown, N.Y., 3 orders.
Ft. Henry, N. Y.
Gainsville, Fla.
Hollidaysburg, Pa.
Waterville, N. Y.
Huntington, L. I.
Lexington, Mo.
Mendota, Ill.
Circleville, O.
Joplin, Mo.
Ashville, N. C.
Youngstown, O.
Kingston & Rondout, N. Y.

CORRESPONDENCE SOLICITED.



KERN INCANDESCENT GAS LIGHT COMPANY'S SYSTEMS.

SAVES 80 PER CENT. OF YOUR GAS BILL.

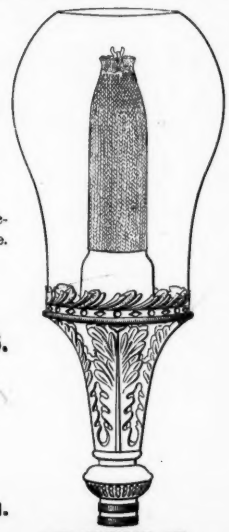
THE NEW DISCOVERY.
BURNS ONE CUBIC FOOT OF GAS PER HOUR.

No Chimneys to Break. Mantles do not Blacken. Better than Electricity, and only 1-10th the Cost. Not a mere statement, but a Guarantee.

CAN BE USED WITH { MANUFACTURED GAS. NON-CARBURETTED GAS. NATURAL GAS OR GASOLINE GAS.

35 TO 40 CANDLES PER CUBIC FOOT.

Burner No.	0	consumes	8-10	cubic foot,	30-candle power.
"	1	"	1	"	35 "
"	2	"	2	cubic feet,	70 "
"	3	"	3	"	105 "
"	4	"	4	"	140 "
"	7	"	7	"	225 "



Prices Reasonable. Catalogues on Application. Agents Wanted.

Kern Incandescent Gas Light Company, { 18 MURRAY ST., NEW YORK.

JOHN CABOT,

Purifier Trays.

We make up Trays with any shaped slat you may desire.

Our experience of 20 years of Tray making is at your service.

553-557 West 33d Street, NEW YORK CITY.

Bristol's Recording

PRESSURE GAUGE.

For continuous records of **Street Gas Pressure.** Simple in construction, accurate in operation, and low in price.

Fully Guaranteed. Send for Circulars.

THE BRISTOL CO.,

Waterbury, Conn.

Silver Medal, Paris Exposition.

CHAPMAN VALVE MANUFACTURING CO.

MANUFACTURERS OF

Valves and Gates for Gas, Ammonia, Water, Etc.

Also, Gate Fire Hydrants with and without Independent Nozzle Valve. All Work Guaranteed.

Works & Gen'l Office, Indian Orchard, Mass. Treasurer's Office, 72 Kilby & 112 Milk Sts., Boston Mass
Chicago Office, 24 West Lake St. New York Office, 28 Platt St.
St. Louis Office, L. M. Rumsey Mfg. Co., 810 North Second St.

THE

Ludlow Valve Mfg. Co.,

TROY, N. Y., U. S. A.

Double and Single Gate Valves, ¼" to 72",

—FOR—

Gas, Water, Steam, Oil, Ammonia, Etc.

HOT GAS VALVES A SPECIALTY.

Send for Catalogue.

Steward Burners.

Closest Attention to **Durability, Candle Power, Finished Appearance.**

Samples to be Had for the Asking.

Write for neat vest pocket memorandum book. Sent Free.

The D. M. Steward Mfg. Co.,

New York Office, 107 CHAMBERS ST. CHATTANOOGA, Tenn.

BRAY BURNERS.

WILLIAM M. CRANE COMPANY,

SOLE AGENTS FOR UNITED STATES,
1131-1133 Broadway, New York.

THE THOMAS DAY COMPANY,
Distributing Agents for Pacific Coast,
San Francisco, Cal.

SAFETY GAS MAIN STOPPER CO.

108 EAST 117TH ST., N. Y.

FOR SHUTTING OFF GAS IN MAINS TEMPORARILY DURING ALTERATIONS AND REPAIRS

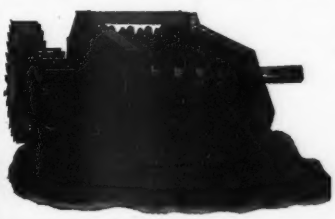
THE LINK-BELT MACHINERY CO.,

ENGINEERS, FOUNDERS, MACHINISTS,
Chicago, U. S. A.

LINK-BELT ELEVATING & CONVEYING MACHINERY for HANDLING COAL, COKE, OXIDE, ETC.

Tilting Coal and Coke Cars, Breaker Rolls, Shaking Screens, Power Transmitting Machinery.

Machinery designed and erected to suit existing conditions and available space.



"Link-Belt" Breaker.

CATALOGUE UPON APPLICATION

AMERICAN GAS COMPANY

Constructors of Coal Gas Apparatus.

EASTERN AGENTS FOR

BREDEL'S SYSTEM
COAL GAS PLANTS AND GAS APPARATUS.

P. H. & F. M. ROOTS CO.'S
Exhausters, Governors, etc.

GENERAL AGENTS FOR

BRONDER'S CHARGING AND DISCHARGING MACHINES.

AMERICAN GAS COMPANY,

222 South Third Street, Philadelphia, Pa.

FRED. BREDEL, C.E.

Coal and Water Gas Plants.

OWN SYSTEM.

RECUPERATIVE FURNACES, WASHERS, CONDENSERS, PURIFIERS, PURIFYING MACHINES, COKE CONVEYERS, ETC.

SOLE UNITED STATES AGENT FOR
ARROL-FOULIS MECHANICAL CHARGING AND DRAWING MACHINES.

Gas Enriching Plants to Enrich Coal Gas up to 24 Candle Power, and Making a White, Bright, Non-smoking Gas.

GAS RETORTS AND SPECIAL BLOCKS AND FIREBRICK MANUFACTURED UNDER THE SUPERINTENDENCE OF MY OWN CHEMIST.

COMPLETE GAS WORKS

No. 118 Farwell Avenue, · Milwaukee, Wis.

Eastern Agents: AMERICAN GAS CO., Construction Department, 222 So. 3d St., Phila., Pa.

ROOTS'

LATEST IMPROVED GAS EXHAUSTER

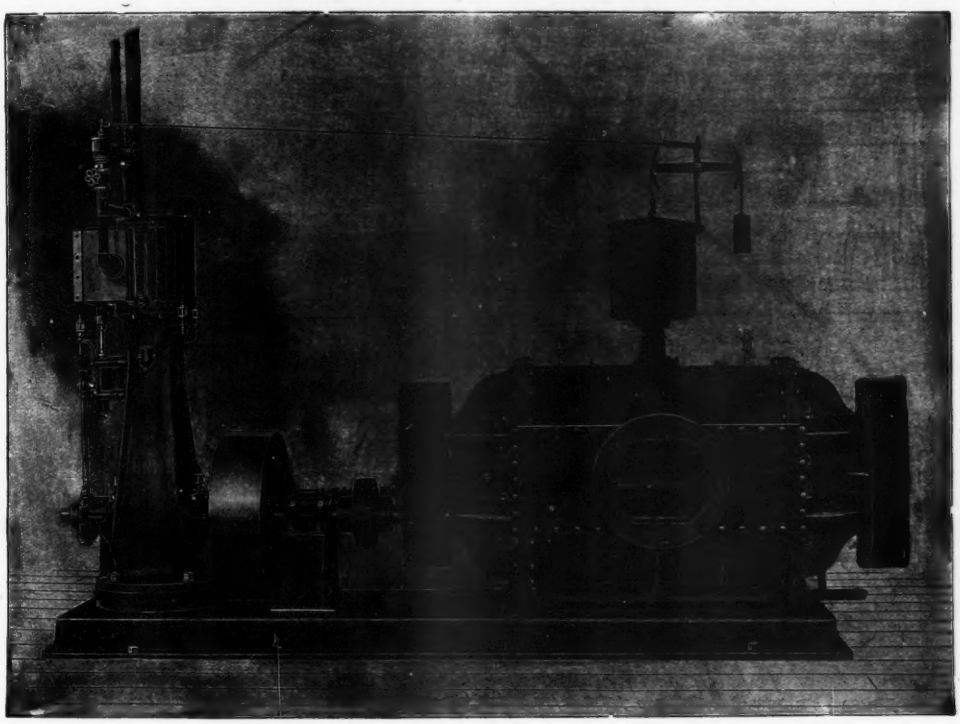
—AND—

NEW GAS GOVERNOR AND STEAM VALVE.

GUARANTEED TO REGULATE WITHIN ONE-TENTH OF AN INCH, WATER PRESSURE.

The Most Perfect Gas Governor on the Market.

MORE DIRECT IN ACTION. FEWER PARTS.
EASIER TO ADJUST THAN ANY OTHER GOVERNOR.



INQUIRIES CHEERFULLY ANSWERED. WRITE FOR CATALOGUE.

P. H. & F. M. ROOTS CO.,

Connersville, Ind. 109 Liberty St., New York.

Eastern Office:

American Gas Company,

222 South Third Street, Philadelphia, Pa.

WARREN FOUNDRY AND MACHINE CO.,

Established 1856. Works at Phillipsburgh, N. J.

New York Office, 160 Broadway.

CAST IRON WATER AND GAS PIPE,

FROM THREE TO FORTY-EIGHT INCHES DIAMETER. ALSO, ALL SIZES OF

Flange Pipe for Sugar House and Mine Work. Branches, Bends, Retorts, etc., etc.

"GLOBE" SPECIALS "PATENTEE" "GLAMORGAN" PIPE FITTINGS

M. J. DRUMMOND & CO.

MANUFACTURERS OF

CAST IRON

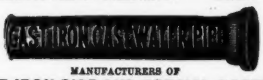
GENERAL SALES OFFICE, 192 BROADWAY, NEW YORK.

Western Office: Monadnock Block, Chicago, Ills.

GEORGE ORMROD, Manst. & Treas., Emaus, Pa.
JOHN DONALDSON, Prest., Betz Bldg., Phila., Pa.

EMAUS PIPE FOUNDRY.

DONALDSON IRON COMPANY. EMAUS, PA



MANUFACTURERS OF

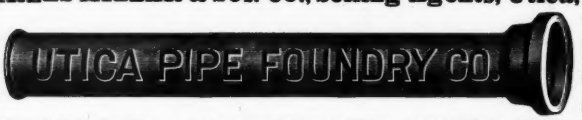
CAST IRON PIPE AND SPECIAL CASTINGS

FOR WATER AND GAS.

Also, FLANGE PIPE, LAMP POSTS, Etc.

CHARLES MILLAR & SON CO., Selling Agents, Utica, N.Y.

Flanged Pipe and Fittings, Hydrants, Gates, Pig Lead, Jute, etc.



Manufacturers of Lead Pipe, Solder, etc., and Jobbers of Plumbers' and Tinners' Goods.

CAST IRON PIPE and SPECIALS FOR WATER AND GAS.

Wholesale Eastern Agents AKRON VITRIFIED SEWER PIPE.

CORNELL & UNDERHILL,

Wrought & Cast Iron Pipe,

MALLEABLE AND CAST IRON FITTINGS,

Brass and Iron Cocks and Gate Valves,

43, 45 AND 47 BEACH ST., NEW YORK.

BINDER for the JOURNAL.

Price, $1 00.

A. M. CALLENDER & CO., 32 Pine Street, N.Y.

CHRIS. CUNNINGHAM & SON,

PROPRIETORS,

THE NOVELTY STEAM BOILER WORKS,

BROOKLYN, N. Y.

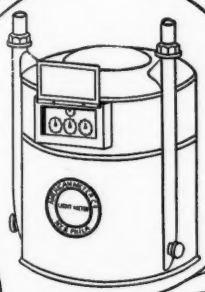
STORAGE TANKS FOR GAS WORKS,

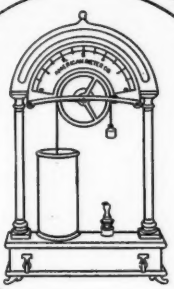
To Retain Fluid Material of Any Sort.

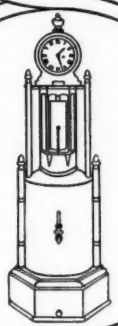
PIPING IN AND AROUND GAS WORKS.

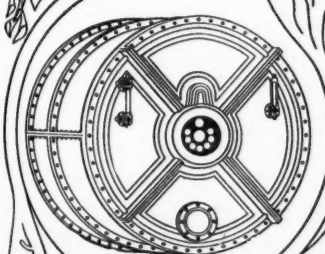
Work Done for Several of the Largest Gas Companies in America Stands as Reference.

(Copyrighted, 1894, by the AMERICAN METER CO.









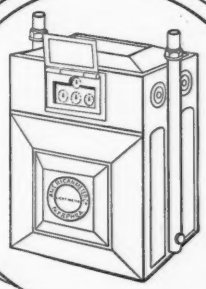
AMERICAN METER CO.

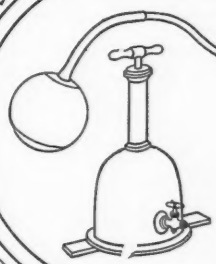
ESTABLISHED 1836. INCORPORATED 1863.

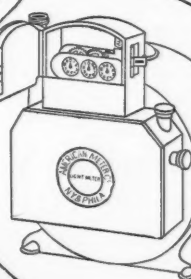
NEW YORK AND PHILADELPHIA,

CHICAGO, ST. LOUIS,

SAN FRANCISCO.







PUBLIC LIGHTING TABLE.

NOVEMBER, 1900.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
				P.M.	A.M.
Thu.	1	12.10 AM	5.30 AM	4.45	5.35
Fri.	2	1.30	5.30	4.45	5.35
Sat.	3	2.40	5.30	4.45	5.35
Sun.	4	3.50	5.30	4.45	5.35
Mon.	5	No L.	No L.	4.40	5.45
Tue.	6	No L. FM	No L.	4.40	5.45
Wed.	7	No L.	No L.	4.40	5.45
Thu.	8	5.20 PM	7.20 PM	4.40	5.45
Fri.	9	5.20	8.20	4.40	5.45
Sat.	10	5.20	9.20	4.40	5.45
Sun.	11	5.10	10.30	4.40	5.45
Mon.	12	5.10	11.30	4.30	6.00
Tue.	13	5.10 LQ	12.30 AM	4.30	6.00
Wed.	14	5.10	1.30	4.30	6.00
Thu.	15	5.10	2.20	4.30	6.00
Fri.	16	5.10	3.20	4.30	6.00
Sat.	17	5.10	4.20	4.30	6.00
Sun.	18	5.10	5.50	4.30	6.00
Mon.	19	5.10	5.50	4.25	6.00
Tue.	20	5.10	5.50	4.25	6.00
Wed.	21	5.10 NM	5.50	4.25	6.00
Thu.	22	5.10	5.50	4.25	6.00
Fri.	23	5.10	5.50	4.25	6.00
Sat.	24	5.10	5.50	4.25	6.00
Sun.	25	5.10	6.00	4.25	6.00
Mon.	26	7.50	6.00	4.20	6.10
Tue.	27	9.00	6.00	4.20	6.10
Wed.	28	10.00	6.00	4.20	6.10
Thu.	29	11.10 FQ	6.00	4.20	6.10
Fri.	30	12 20 AM	6.00	4.20	6.10

TOTAL HOURS LIGHTING DURING 1900.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	230.50	January	423.20
February	175.40	February	355.25
March	189.00	March	355.35
April	160.30	April	298.50
May	150.40	May	264.50
June	137.00	June	234.25
July	152 00	July	243.45
August	171.50	August	280.25
September	187.20	September	321.15
October	213.10	October	374.30
November	221.50	November	401.40
December	231.50	December	433.45
Total, yr.	2221.40	Total, yr.	3987.45

NEW YORK, 33 Nassau St. PHILADELPHIA, Broad and Arch Sts. CHICAGO, 54 Lake St.

Welsbach Street Lighting Company

.... OF AMERICA ....

No. 36.

Controls and Operates the

Welsbach System of Street Lighting,

Which includes its specially DESIGNED AND PATENTED BURNER for STREET and PARK LIGHTING exclusively.

Uniformly SUCCESSFUL in seventy-five Cities and Towns.

By means of the Welsbach System of street lighting the superiority of GAS over electricity for street lighting has been fully demonstrated.

POINTS OF MERIT:

It is { Economical, Attractive, Successful, Up-to-date.

IT LIGHTS THE STREET.

Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.

No. 38.

Correspondence solicited from Gas Companies and others interested in Municipal and outside lighting.

Welsbach Famous Mantles.

THE INCOMPARABLE

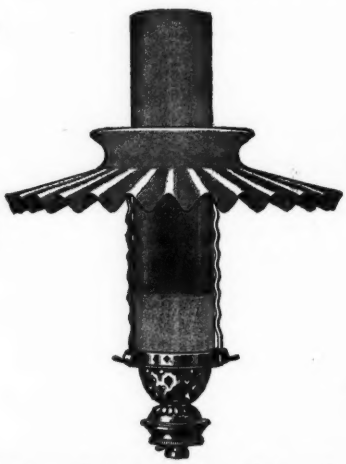
"Yusea" Welsbach Mantle

FINEST EXAMPLE

OF INCANDESCENT

GAS LIGHT

EVER EXHIBITED.



OTHER WELSBACH BRANDS —OF— Magnificent Brilliancy —AND— Endurance.

THE HIGHEST ILLUMINATION, The Lowest Cost.

Welsbach Lamps, Mantles, and Complete Line of Glassware and Supplies

WELSBACH COMPANY,

GLOUCESTER, N. J.

Chicago Branch Department and Supply House, - - - - - 70 Wabash Avenue.

THE UNITED GAS IMPROVEMENT COMPANY.

THE STANDARD DOUBLE SUPERHEATER LOWE WATER GAS APPARATUS.

CONTRACTS RECEIVED SINCE JANUARY 1, 1900.

	SETS.		SETS
DANSVILLE, N. Y.	1	HACKENSACK, N. J.	1
WEST CHESTER, PA.	1	TIFFIN, O.	1
COHOES, N. Y.	2	MOUNT HOLLY, N. J.	1
OGDEN GAS CO., CHICAGO	1	SEATTLE, WASH.	1
CENTRAL UNION GAS CO., NEW YORK	1	TARRYTOWN, N. Y.	1
SPENCER, MASS.	1	HOBOKEN, N. J.	2
SAN FRANCISCO	1	PATERSON, N. J.	2
BROOKLYN UNION GAS CO., BROOKLYN	1	NEWARK, N. J.	2
RICHMOND, VA.	2	JERSEY CITY, N. J.	1
CAMBRIDGE, MASS.	2	AUSTIN, TEX.	1
CARBONDALE, PA.	1		

NUMBER OF SETS 27
TOTAL SETS INSTALLED TO JANUARY 1, 1900 327

TOTAL SETS INSTALLED TO DATE 354
TOTAL DAILY CAPACITY . . . . . 226,600,000 Cubic Feet.

The United Gas Improvement Company,

Broad and Arch Streets, Philadelphia.

Established 1858. Incorporated 1890.
CHAS. E. GREGORY Prest. DAVID R. DALY V. Prest. & Treas.
H. D. ABERNETHY, Sec.

J. H. Gautier & Co.

Greene & Essex Streets,
Jersey City, N. J.

MANUFACTURERS OF

CLAY GAS RETORTS, FIRE CLAY TILES,
FIRE BRICK and FIRE CLAY SPECIALTIES.

Ground Fire Clay, Fire Sand and Ground Fire Brick in Barrels and Bulk.

SOLE MANUFACTURERS OF THE

FLEMMING GENERATOR GAS FURNACE

E. D. WHITE, President. A. H. GUTKES, Vice-President. H. A. PERKINS, Secretary.

Brooklyn Fire Brick Works,

MANUFACTURERS OF

CLAY RETORTS, FIRE BRICK,
Gas House and other Tile.

Office, 88 Van Dyke St. Brooklyn, N. Y

Established 1854. Incorporated 1869.

LACLEDE
Fire Brick Manufg. Co.,

Manufacturers of { CAS RETORTS . .
FIRE BRICK . . .
RETORT SETTINGS

Water Gas Cupola Linings, Fire Clay, Etc.

Proprietors for the U. S., Coze System of Inclined Benches.

Estimates Furnished on Application for Most Successful Style of Construction.

Also for Free-Firing and Full and Half-Depth Regenerative Benches, for Burning either Coal or Coke in the Furnaces.

Office:
914, 915 & 916 Wainwright Building, St. Louis, Mo.

The Construction of Gas Works

PRACTICALLY DESCRIBED,

By WALTER RALPH HERRING.

Price $2. For Sale by

A. M. CALLENDER & CO.,

32 Pine Street, N. Y. City.

Adam Weber,

Proprietor,

Manhattan Fire Brick and Enameled Clay Retort Works.

Works, Weber, N. J.

Office, 633 East 15th St., New York.

Modern Recuperative Furnaces

And Standard Fire Brick and C. e Retorts.

Works,
LOCKPORT STATION, PA.

—ESTABLISHED 1864.—

JAMES GARDNER, JR., CO.,

Hamilton Building, Fifth Avenue,
PITTSBURGH, PA. P. O. Box 373.

Successor to WILLIAM GARDNER & SON,

Fire Clay Goods for Gas Works.

SOLE REPRESENTATIVE OF THE McILHENNY REGENERATIVE BENCHES FOR THE U. S.

HENRY MAURER & SON,

(ESTABLISHED 1856.)

EXCELSIOR FIRE BRICK & CLAY

RETORT WORKS

WORKS, Perth Amboy, N. J.

OFFICE, 418 to 422 East 23d St., N. Y.

Clay Gas Retorts,

BENCH SETTINGS,

Fire Brick, Tiles, Etc.

GEROULD'S IMPROVED RETORT CEMENT

A Cement of great value for patching retorts, putting on mouthpieces, making up all bench-work joints, lining blast furnaces and cupolas. This cement is mixed ready for use. Economic and thorough in its work. Fully warranted to stick.

Price List, f.o.b. Galesburg, Ills., or Buffalo, N. Y.

In Casks, 400 to 800 pounds, at 5 cents per pound.
In Kegs, 100 to 200 " " 6 " "
In Kegs less than 100 " " 7 " "

C. L. GEROULD, Galesburg, Ills.

For orders East of Buffalo, N. Y., or Pittsburg, Pa., freight will be paid to these points.

Parker-Russell Mining and Mfg. Co.,

CITY OFFICE,
417 Pine Street, St. Louis, Mo.

PROPRIETORS OF THE

OAKHILL GAS RETORT & FIRE BRICK W'KS

Our immense establishment is now employed almost entirely in the manufacture of

Materials for Gas Companies

We have studied and perfected three important points. Our retorts are made to stand changes of temperature, the strongest heats of the furnace, and the abrasion of feeding and emptying. We construct

Half and Full Depth Benches of Our Own Design,

Containing 6, 8 or 9 Retorts.

We have Greatly Improved our Recuperators. Coal or Coke can be used as Fuel in Furnaces.

THEO. J. SMITH, Prest. J. A. TAYLOR, Sec.
A. LAMBLA, Vice-Prest. and Supt.

BALTIMORE RETORT & FIRE BRICK CO.

MANUFACTORY AT

LOCUST POINT, BALTIMORE, MD.

Clay Retorts, Blocks & Tiles

FIRE BRICK, FIRE CLAY, AND FIRE CEMENT.

Our Improved Half and Full Depth Benches have been Adopted by Many Gas Companies.

WALDO BROS., 102 MILK ST., BOSTON, MASS.

Sole Agents for New England States.

JOHN DELL,
General Manager.

MISSOURI FIRE BRICK CO.,

ESTABLISHED 1882.

— MANUFACTURERS OF —

Gas Retorts, Bench Settings, Fire Brick, Cupola Linings, Etc.

We are prepared to furnish and erect COMPLETE, Half and Full Depth Benches of 6's, 8's, 9's, with Regenerative Furnaces, Constructed to Burn either Coal or Coke. Also Plain Benches.

CORRESPONDENCE IS RESPECTFULLY SOLICITED.

{ CITY OFFICE: 411 Olive St., Continental Bank, } ST. LOUIS, MO.

National Gas and Water Company.

CONTRACTORS FOR
Gas Plant Machinery

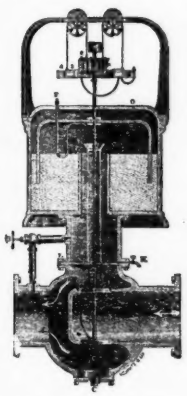
SOFT COAL OR COKE
WATER GAS GENERATORS
A SPECIALTY.

218 LA SALLE ST.,
CHICAGO.

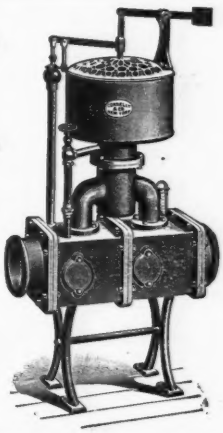
Gas Engineers
INSPECTION AND ADVICE.

PLANS AND ESTIMATES
FOR IMPROVEMENTS OR
REPAIRS.

GAS WORKS SPECIALTIES,



AUTOMATIC STREET GAS GOVERNORS,
BALANCE GAS GOVERNORS.
"Iron Sponge" and Natural Oxide
FOR GAS PURIFICATION.
EXHAUSTERS, ETC.



Connelly Iron Sponge & Governor Co.

No. 357 CANAL STREET,
NEW YORK CITY.

WESTERN BRANCH CONNELLY IRON SPONGE & GOVERNOR CO.,
788 South Canal Street, Chicago, Ills.

Hughes'
"Gas Works,"

Their Construction and Arrangement,

And the Manufacture and Distribution of Coal Gas.

Originally written by SAM'L HUGHES, C.E.

Rewritten and Much Enlarged by
WM. RICHARDS, C.E.

Eighth Edition, Revised, with Notices of Recent Improvements.

Price, $1.65.

A. M. CALLENDER & CO.,
32 Pine St., N. Y. City.

Parson's Steam Blower

FOR IMPROVING BAD DRAUGHT IN BOILERS, AND FOR BURNING BREEZE OR OTHER WASTE MATERIAL.

PARSON'S TAR BURNER,

FOR USING COAL TAR AS FUEL.

PARSON'S AIR JET TUBE CLEANER.

FOR CLEANING BOILER TUBES.

These devices are all first-class. They will be sent to any responsible party *for trial*. No sale unless satisfactory. Manufactured by the WATERTOWN STEAM BLOWER COMPANY.

H. E. PARSON, Supt., 457 Putnam Ave., Brooklyn, N. Y.

The Chemistry of Illuminating Gas,
By NORTON H. HUMPHRYS. Price, $2.40.
A. M. CALLENDER & CO., 32 PINE ST., N. Y. CITY.

The Gas Engineer's Laboratory Handbook,
By JOHN HORNBY, F.I.C.
Price, $2.50.
A. M. CALLENDER & CO., 32 Pine Street, N. Y. City

Practical Hints on the Construction and Working of Regenerator Furnaces,
By MAURICE GRAHAM, Assoc M.Inst.C.E.
Price, $1.25. For Sale by
A. M. CALLENDER & CO., No. 32 Pine Street, New York City.

JAMES D. PERKINS, President. F. SEAVERNS, Treasurer.

THE PERKINS COMPANY,

228 and 229 Produce Exchange, New York City.

TIDEWATER SALES AGENTS FOR THE FOLLOWING:

Ocean Mine Youghiogheny Gas Coal,
Old Kentucky Shale and O. K. Boghead.

SHIPMENTS FROM NEW YORK, PHILADELPHIA, BALTIMORE AND NORFOLK.

BERWIND-WHITE COAL MINING COMPANY'S

Ocean Westmoreland Gas Coal.

Offices:
Washington Building, New York.
Betz Building, Philadelphia.

STRICTLY High Grade. . . . .
Carefully prepared.
For Gas Making or
Heavy Steaming.

SCIENTIFIC BOOKS.

GAS MANUFACTURE, THE CHEMISTRY OF, by W. J. A. Butterfield. $3.50.

NEWBIGGING'S HANDBOOK. By Thos. Newbigging. 6th edition. $6.

COX'S GAS FLOW COMPUTER. $2.50.

FIELD'S ANALYSIS, 1898. $5.

HUGHES' GAS WORKS. $1.65.

POOLE ON FUELS. By Herman Poole. $3.

GAS ENGINEER'S POCKET-BOOK. By Henry O'Connor. $3.50.

TECHNICAL GAS ANALYSIS. $3.

GAS CONSUMER'S HANDYBOOK, by Wm. Richards. 20 cents.

CHEMISTRY OF ILLUMINATING GAS. By Norton H. Humphrys. $2.40.

PRACTICAL TREATISE ON HEAT By Thomas Box. 2d edition. $5.

PRACTICAL PHOTOMETRY: A Guide to the Study of the Measurement of Light. By W. J. Dibdin. $3.

CHEMICAL TECHNOLOGY: Vol. I., *Fuel and Its Applications*, $5. Vol. II., *Lighting*, $4.

IRONWORE: Practical Designing of Structural Ironwork. By H. Adams. $3.50.

HEMPEL'S GAS ANALYSIS, $2.

LIQUID FUEL FOR MECHANICAL AND INDUSTRIAL PURPOSES. By E. A. Brayley Hodgetts. $2.50.

COAL: Its History and Use. By Prof. Thorpe. $3.50.

PRACTICAL HANDBOOK ON GAS ENGINES, by G. Lieckfield. $1.

HEAT A MODE OF MOTION. By John Tyndall. $2.50.

THEORY OF HEAT. By J. Clerk-Maxwell. $1.50.

MANUAL FOR GAS ENGINEERING STUDENTS. By D. Lee. 40 cents.

GASFITTER'S GUIDE, by John Eldridge 40 cents.

AMMONIA AND AMMONIUM COMPOUNDS. By Dr. R. Arnold. $2

CONSTRUCTION OF GAS WORKS, by Walter Ralph Herring. $2.

DIGEST OF GAS CASES. $5.

PRACTICAL HINTS ON REGENERATOR FURNACES By M. Graham. $1.25.

A TREATISE ON THE COMPARATIVE COMMERCIAL VALUES OF GAS COALS AND CANNELS. By D. A. Graham. $3.

A TEXT BOOK OF INORGANIC CHEMISTRY. By Prof. Victor Von Richter. $2.

ILLUMINATING AND HEATING GAS. By W. Burns. $1.50

HANDBOOK FOR MECHANICAL ENGINEERS. By H. Adams. $2.50.

TREATISE ON MASONRY CONSTRUCTION. Baker. $5

GAS ENGINEER'S LABORATORY HANDBOOK. By Jno. Hornby. $2.50.

GAS LIGHTING AND GAS FITTING. By W. P. Gerhard. 50 cents.

PRACTICAL PLUMBING. By P. J. Davies. $3.

AMERICAN PLUMBING. By Alfred Revill. $2.

CEMENT; A Manual of Lime and Cement, their Treatment and Use in Construction. By A. H. Heath. $2.50.

A COMPARISON BETWEEN THE ENGLISH AND FRENCH METHODS OF ASCERTAINING THE ILLUMINATING POWER OF COAL GAS. $1.60.

ELECTRICITY.

INDUSTRIAL PHOTOMETRY, with Special Application to Electric Lighting. By A. Palaz, Sc.D. $4.

ELEMENTS OF ELECTRIC LIGHTING, Including Electric Generation, Measurement, Storage and Distribution. By Philip Atkinson. $1.50.

ELECTRIC TRANSMISSION OF ENERGY. By G. Kapp $3.50.

ELECTRICIAN'S POCKETBOOK. By Monroe and Jamieson. $2.50.

DYNAMO BUILDING. By F. W. Walker. 50 cents.

DOMESTIC ELECTRICITY FOR AMATEURS. By E. Hospitalier. $2.50.

PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS. $1.

PRACTICAL GUIDE TO THE TESTING OF INSULATED WIRES AND CABLES. $1.

ELECTRIC LIGHTING, by Francis B. Crocker. $3.

ELECTRIC LIGHT FITTING. $2.

PRACTICAL ELECTRICITY. $2.50.

ELECTRICITY FOR ENGINEERS. $2.50.

ELECTRICITY, Its Theory, Sources and Applications. By John T. Sprague. $6.

The above will be forwarded upon receipt of price. If sent by mail or express, postage or express charges must be added to above prices. We take especial pains in securing and forwarding any other Works that may be desired, upon receipt of order. All remittances should be made by check, draft, or post office money order. No books sent C.O.D.

A. M. CALLENDER & CO., 32 Pine Street, New York.

The Despard Gas Coal Co.,

MINERS AND SHIPPERS OF

DESPARD GAS COAL,

AND MANUFACTURERS OF

COKE.

MINES, - - Clarksburgh, Harrison Co., West Va.
WHARVES, - - - Locust Point Baltimore, Md.
OFFICE, - 640 Equitable Building Baltimore, Md.

ROUSSEL & HICKS, 71 Broadway, N. Y. } AGENTS, { BANGS & HORTON 60 Congress St., Boston.

KELLER ADJUSTABLE COKE CRUSHER.

Strong, Simple, Durable. Will Crush any Size Desired.

C. M. KELLER,
Sec. & Supt. Gas Lt. & Coke Co.,
Columbus, Ind.
Correspondence Solicited.

Do You Wish to Know

what size of pipe to use to convey any quantity of gas, any distance, with any loss of pressure and any initial or final pressure? Then use

Cox's Gas Flow Computer,

as it gives this information accurately at sight, without mental effort. No calculations needed. Saves time, money and mistakes.

Price, 6.5 x 8 inches, in cloth case, $2.50. For sale by

A. M. Callender & Co., 32 Pine St., N. Y.

GREENOUGH'S "DIGEST OF GAS CASES."

Price, $5.00.

This is a valuable and important work, a copy of which should be in the possession of every gas company in the country, whether large or small. As a book of reference it will be found invaluable. It is the only work of the kind which has ever been published in this country, and is most complete. Handsomely bound. Orders may be sent to

A. M. CALLENDER & CO., 32 Pine St., N. Y.

MADEIRA, HILL & CO.,

INCORPORATED.

MINERS AND SHIPPERS

Anthracite and Bituminous Coal and Coke.

GENERAL EASTERN SALES AGENTS

PENN GAS COAL CO.

OPERATING THE FAMOUS MINES IN THE

YOUGHIOGHENY COAL BASIN.

OWNERS OF OVER 1,000 COAL CARS.

COAL CAREFULLY SCREENED AND PREPARED FOR GAS PURPOSES.

OFFICES:

PHILADELPHIA, 32 South Broad Street. BOSTON, 70 Kilby Street. NEW YORK, 143 Liberty Street.
BRIDGEPORT, CONN. READING, PA.

EDMUND H. McCULLOUGH, Prest. CHAS. F. GODSHALL, Treas. H. C. ADAMS, Sec.

THE WESTMORELAND COAL CO.

Chartered 1854.

Mines situated on the Pennsylvania and the Baltimore and Ohio Railroads, in Westmoreland County, Pa.

POINTS OF SHIPMENT:

PHILADELPHIA, BALTIMORE, SOUTH AMBOY, N. J.,
WATKINS (SENECA LAKE), N. Y.

Since the commencement of operations by this Company its well-known Coal has been largely used by the Gas Companies of New England and the Middle States, and its character is established as having no superior in gas-giving qualities, and in freedom from sulphur and other impurities.

Principal Office, 224 South 3d St., Phila., Pa.

THE SUN OIL CO.,

Crude Oil, Gas Naphtha,
Refined Petroleum, Gas Oil.

Toledo, O., and Pittsburgh, Pa.

Standard Oil Company,

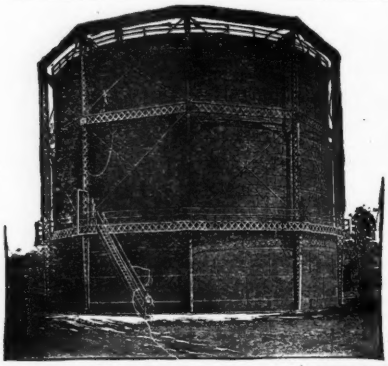
GAS NAPTHA DEPARTMENT.

GAS NAPTHA.

GAS OIL.

Correspondence Solicited.

26 Broadway, New York City.



DAVIS & FARNUM MFG. CO.,
WALTHAM, MASS.

Principal Office & Works, Waltham, Mass. Boston Office, R'm 18, Vulcan Bldg., 8 Oliver St.

Single, Double and Triple-Lift Gasholders of any Capacity. Tubular, Pipe and Sinuous Friction Condensers of all Sizes.

Steel Tanks for Gasholders, Iron Roof Frames and Floors Purifying Boxes, Center Seal or Valve Connections, Bench Work, Reversible Lime Trays.

Self-Sealing and Pressed Steel Mouthpiece Lids.

Coke Borrows, Coal Wagons, and all Apparatus Requisite for a Complete Gas Works.

Also, Gas and Water Pipe, Flanged Pipe, Sugar House Work, and Special Castings of all Descriptions.

BAXTER & YOUNG,
CONTRACTING AND CONSULTING GAS ENGINEERS.

Examination and Values Ascertained of Artificial and Natural Gas Properties.

COMPLETE GAS WORKS ERECTED.

Artificial and Natural Gas Mains Furnished and Laid.

CORRESPONDENCE SOLICITED.

OFFICE: WAYNE COUNTY BANK BUILDING, Rooms 201 & 202. DETROIT, MICH

A. E. BOARDMAN, C. E.,
Consulting and Contracting Engineer.

Particular attention given to Gas, Water and Electric Plants. Long and successful experience with the problem and practice of

Filtration for Public Water Supply.

BREVARD, N. C.

Geo. Shepard Page's Sons.
GAS MACHINERY.

Correspondence Solicited.

180 Fulton Street, New York City.

JAMES T. LYNN,
GAS ENGINEER AND CONTRACTOR,

Wayne Bank Building, - DETROIT

GAS PROPERTIES PURCHASED.

DAVID LEAVITT HOUGH,
Consulting Engineer AND CONTRACTOR,

374 FIFTH AVE., N. Y

Kerr Murray Manufacturing Company,

Steel Gasholder Tanks,

SINGLE, DOUBLE AND TRIPLE-LIFT GASHOLDERS

HORIZONTAL AND VERTICAL STORAGE OIL TANKS

Iron Work for Coal Gas Benches, Self-Sealing Mouthpieces, Exhausters, Condensers, Scrubbers, Purifiers, Wooden Trays, Floor Carriages, Center Seal and Valve System Connections, Cast and Wrought Iron Fittings, and Connections 3 to 36 Inches Diameter.

VALVES, Double Gate, Hub and Flange, Outside Screw and Quick Opening, 3 to 36 In. Diam.

COAL AND COKE WAGONS, RETORT HOUSE TOOLS, STREET MAIN SPECIALS AND DRIPS.

Address,

KERR MURRAY MANUFACTURING CO.
Fort Wayne, Indiana.

BARTLETT, HAYWARD & CO.

BALTIMORE, MD.

Triple, Double and Single-Lift Gasholders.

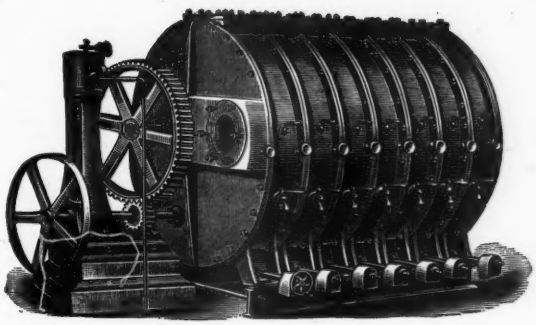
Iron Holder Tanks.

ROOF FRAMES.

Girders.

BEAMS

PURIFIERS.



CONDENSERS.

Scrubbers.

Bench Castings.

OIL STORAGE TANKS.

Boilers.

PATENT STANDARD WASHER-SCRUBBER.

The best apparatus for the extraction of all Ammonia and a large proportion of Carbonic Acid and Sulphureted Hydrogen. The Scrubber has been materially improved and is provided with patented Wooden Segmental Grids, instead of Metallic Discs, thus reducing the weight on shaft and power for operating same.

The Wilkinson Water Gas Process.

THIRTY-CANDLE, NON-CONDENSABLE, FIXED GAS. THE MOST SUCCESSFUL GAS PROCESS IN OPERATION.

MILL'S REVERSIBLE LIME TRAYS.

Gas Works Designed and Constructed.

ALEX. C. HUMPHREYS, M. E., M. Inst. C. E. ARTHUR G. GLASGOW, M. E., M. Inst. C. E.

HUMPHREYS & GLASGOW,

BANK OF COMMERCE BLDG., 31 Nassau Street New York.

9 VICTORIA STREET, London S. W., England.

CONSULTING GAS ENGINEERS AND MANAGERS.

GAS PROPERTIES PURCHASED.

GASHOLDER TANKS AND GAS WORKS MASONRY COMPLETE

Plans prepared and Estimates furnished at short notice.

J. P. WHITTIER,

238 Java Street, Brooklyn, N. Y.

GEORGE R. ROWLAND.

Formerly with the Continental Iron Works.

Draughtsman and Constructing Engineer.

Drawings, Specifications and Estimates furnished for the construction of new works or alteration of old works. Special attention given to Patent Office drawings.

Office, No. 245 Broadway, N. Y. City.

R. D. WOOD & CO.,

400 CHESTNUT ST., PHILADELPHIA,

Producer Gas Power Plants,

—WITH—

GAS PRODUCERS.

The best Producer for either Bituminous, Anthracite Coal or Lignite. Less labor required and less waste than any other Producer. Patented in the United States and all Foreign Countries. Send for Pamphlet.

HYDRAULIC TOOLS. **CAMDEN HIGH PRESSURE VALVES.**

ISBELL-PORTER CO.,

ENGINEERS AND CONTRACTORS FOR THE

Construction and Extension of Gas Works.

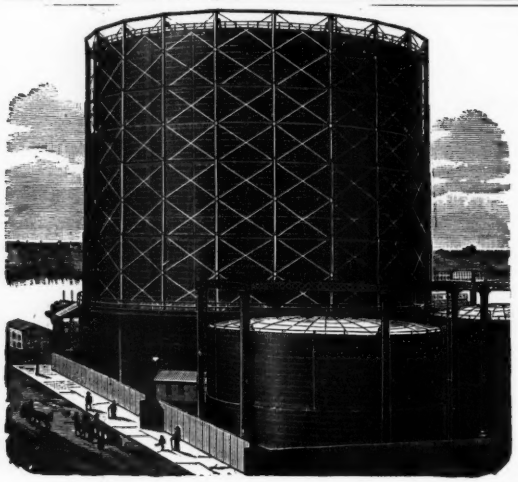
FOUNDERS AND MACHINISTS.

MANUFACTURERS OF

All Ironwork and Machinery Required in a Gas Plant.

Estimates, Drawings and Specifications furnished for the Alteration, Improvement, or Extension of Existing Works or the Construction of New Works.

245 Broadway, New York City. —OFFICES— **Bridge & Ogden Sts., Newark, N. J.**



The Continental Iron Works,

THOMAS F. ROWLAND, President.
WARREN B. HILL and CHAS. H. CORBETT, Vice-Presidents.
THOMAS F. ROWLAND, Jr., Secretary & Treasurer.

West and Calyer Sts. (Near 10th & 23d St. Ferries)
NEW YORK, Borough of Brooklyn.

BUILDERS OF

Gas Holders.

Single and Multiple Section Gas Holders a Specialty.

STEEL GAS HOLDER TANKS.

BENCH CASTINGS, RETORT LIDS.

Hydraulic Mains, Condensers, Scrubbers, Purifiers, Valves, Etc.

Self-Sealing Retort Mouthpieces & Lids

For Round, Oval, or "D" Retorts.

ILLUMINATING GAS! FUEL GAS!

THE LOOMIS PROCESS.

Now in successful operation at Works of John Russell Cuttlery Co., Turner's Falls, Mass., and Henry Disston's Son's Saw Works, Tacony, Pa.

The Cheapest Gas Generating System in the World.

Plans and Estimates Furnished.

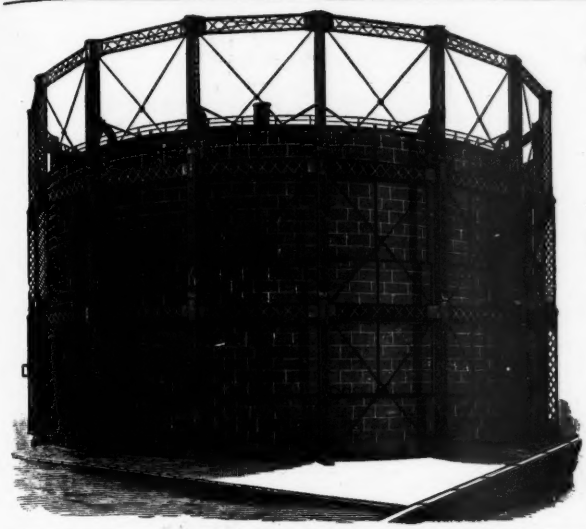
BURDETT LOOMIS, - - Hartford, Conn.

To Gas Companies.

We make to order **CAP BURNERS** to burn any amount under a stated pressure. Send for samples.

Also SERVICE CLEANERS, DRIP PUMPS, and STREET MAIN PROVING APPARATUS.

C. A. GEFRORER,
248 N. 8th St., Phila., Pa.



WILLIAM STACEY, Prest. J. E. STACEY, Vice-Prest. & Gen. Mangr. T. H. BIRCH, Asst. Manag'r. R. J. TARVIN, Sec. & Treas.

THE STACEY MANUFACTURING CO.

Established 1851.

Single, Double and Triple-Lift

GASHOLDERS,

Of any Capacity, with or without Wrought Iron or Steel Tanks.

Hydraulic Mains, Condensers, Scrubbers, Purifiers, Valves, etc.

Coal Gas Benches, Roof Frames,

OIL STORAGE TANKS.

Pressed Steel Mouthpiece Lids, Self-Sealing Mouthpiece Lids.

General Office: Cincinnati, O.
Eastern Office: 911 Drexel Building, Philadelphia, Pa.

RITER-CONLEY MFG. CO.,

GASHOLDERS, with or without Steel Tanks.

Purifiers, Condensers, Scrubbers, Oil Tanks, Smoke Stacks.

STEEL ROOFS and BUILDINGS.

PLATE AND STRUCTURAL WORK OF EVERY DESCRIPTION.

GENERAL OFFICE: Pittsburg, Pa. EASTERN OFFICE: 39-41 Cortlandt St., New York City.

WM. HENRY WHITE,

No. 32 Pine Street, - - - New York City.

ENGINEER AND CONTRACTOR FOR THE

ERECTION AND EXTENSION OF

GAS, WATER, AND ELECTRIC LIGHT WORKS.

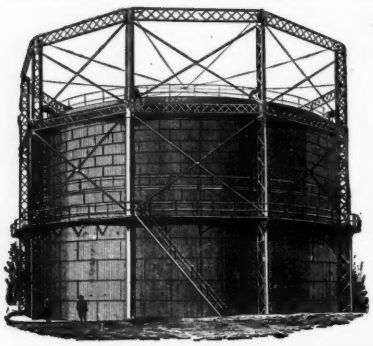
Correspondence with Gas Companies contemplating extending or improving their Plants respectfully invited. Plans and Estimates Furnished.

1900 DIRECTORY 1900

OF AMERICAN GAS COMPANIES.

Price, - - - - - - - - - $5.00.

A. M. CALLENDER & CO., - - No. 32 Pine Street, New York.



1842 ※ Deily & Fowler, ※ 1900

LAUREL IRON WORKS.

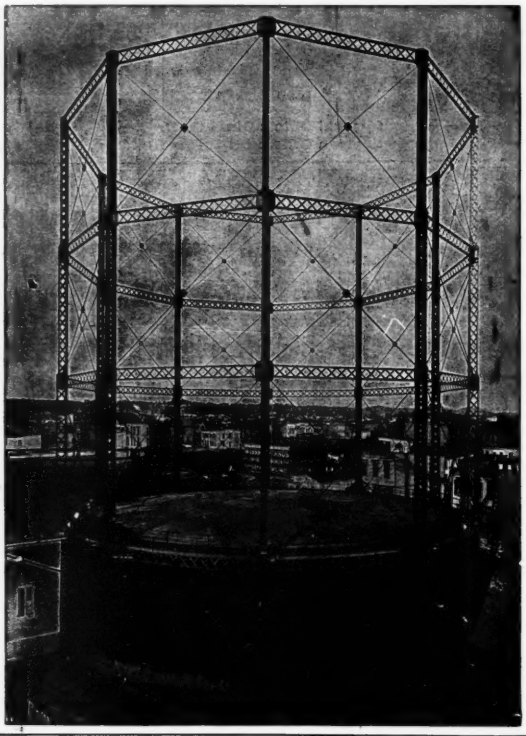
Office, No. 39 Laurel Street, Philadelphia, Pa.

BUILDERS OF

Gasholders

Single or Telescopic. With or Without Iron or Steel Tanks.

OIL TANKS, WATER TANKS, AND GENERAL WROUGHT IRON WORK.



The order for this Triple-Lift Holder and Steel Tank was received by the Logan Iron Works from the Union Gas Light Company, of East New York. The contract was completed and the Holder was in actual use in 90 days from receipt of order. Capacity of Holder, 500,000 Cu.Ft.

LOGAN IRON WORKS,

Brooklyn, N. Y.

MANUFACTURERS OF

Single or Multiple-Lift

GASHOLDERS,

Complete with Steel Tanks.

BENCHES, SCRUBBERS, CONDENSERS, PURIFIERS, IRON ROOFS, Self-Sealing Retort Lids,

AND ALL PARTS OF

GAS WORKS APPARATUS.

Contractors for Complete Works.

ALSO, SOLE MANUFACTURERS OF

C. W. BLODGET'S

HOT GAS SCRUBBER.

FIELD'S ANALYSIS

For the Year 1899.

An Analysis of the Principal Gas Undertakings in England, Scotland and Ireland. Being the Thirtieth Year of Publication.

Compiled and Arranged by

JOHN W. FIELD,

Secretary and General Manager of The Gas Light and Coke Co., London.

Price $5. For Sale by

A. M. CALLENDER & CO., - No 32 Pine Street, N. Y. City.

Established 1854.

D. McDONALD & CO.,

MANUFACTURERS OF

WET AND DRY METERS, STATION METERS AND METER PROVERS.

ALSO MAKERS OF

THE GLOVER PREPAYMENT METER.

The amount of gas delivered for the coin can be instantly and positively changed without removing the meter or replacing any parts.

The gas registered agrees absolutely with the amount purchased by the coin.

WE HAVE MADE AND SOLD IN THE UNITED STATES

OVER 60,000 OF THESE METERS,

ALL OF WHICH ARE GIVING PERFECT SATISFACTION.

Correspondence Solicited.

561 West Forty-seventh Street, NEW YORK. | 51, 53 & 55 Lancaster Street, ALBANY, N. Y. | 34 & 36 West Monroe Street, CHICAGO.

NOW READY.

THE SIXTH (AND CENTENARY) EDITION

— OF THE —

Handbook for Gas Engineers and Managers.

By THOMAS NEWBIGGING, M. Inst. C.E.

This Edition of the "Handbook for Gas Engineers and Managers" is a great improvement on all previous editions. Much of the text has been re-written, in order to keep the work abreast of the constant advances that are being made in the Gas Industry.

PRICE, - - $6.00.

A. M. CALLENDER & CO., - - No. 32 Pine Street, N. Y. City.

PRACTICAL HANDBOOK ON

GAS ENGINES

With Instructions for Care and Working of the Same.

By G. LIECKFELD, C.E.

Translated with Permission of the author by GEO. M. RICHMOND, M.E.

Price, $1.00.

A. M. CALLENDER & CO., 32 Pine Street, New York.

Established 1849. With the best facilities for manufacturing, is enabled to furnish reliable work and answer orders promptly.

NATHANIEL TUFTS METER CO.,

8 Medford Street, Boston, Mass.

MANUFACTURERS OF

DRY GAS METERS.

Station Meters of any Capacity.

Test and Experimental Meters, Pressure Registers, Pressure Gauges.

METER PROVERS, PHOTOMETERS, STREET LANTERNS, ETC., ETC.

Prepayment Gas Meters.

CHARLES E. DICKEY. JAMES B. SMALLWOOD. CHARLES H. DICKEY.

THE MARYLAND METER AND MANUFACTURING CO.

Established 1866.

BALTIMORE, North & Saratoga Sts. **CHICAGO, 107 West Monroe St.**

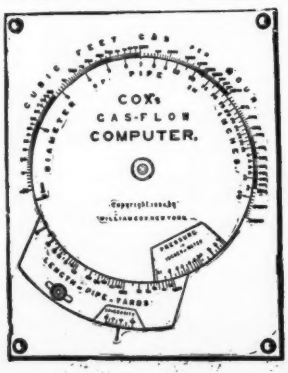
SAN FRANCISCO, 221 Front St.

CONSUMERS' & STATION METERS, PRESSURE GAUGES, Etc., Etc.

"Perfect" Gas Stoves

KEYSTONE METERS, CAREFULLY MADE.

The KEYSTONE METER CO., Royersford, Pa. and WIESTER & CO., 22 Second St., San Francisco.



Do you wish to Know

what size of Pipe to use to convey any quantity of Gas, any distance, with any loss of pressure, and any initial or final pressure? Then use

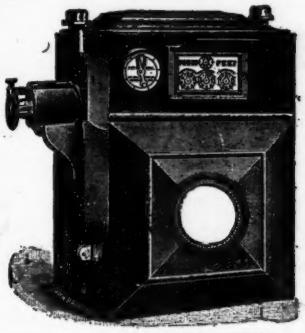
COX'S GAS FLOW COMPUTER,

as it gives this information accurately at sight, without mental effort. No calculations needed. Saves time, money and mistakes.

Price, 6.5 x 8 inches, in cloth case, $2.50.

For sale by

A. M. CALLENDER & CO., 32 Pine St., N. Y. City.



AMERICAN METER COMPANY,

NEW YORK, PHILADELPHIA, SAN FRANCISCO.

PREPAYMENT METERS.

THEIR CONSTRUCTION IS SUCH THAT THEY MAY BE READILY READJUSTED WHEN THE SCALE OF GAS RATES IS CHANGED.

HELME & McILHENNY,

Established 1848. 1339 to 1349 Cherry Street, Philadelphia, Pa.

MANUFACTURERS OF

Wet and Dry Gas Meters, Station Meters, Provers, Gauges, Etc.

METERS REPAIRED

PREPAYMENT GAS METERS.

Our Own Patents. Strong. Simple. PROMPT ATTENTION. CORRESPONDENCE SOLICITED.

METRIC METAL COMPANY,

MAKERS OF

GAS METERS for NATURAL and ARTIFICIAL GAS.

Special Attention given to Repairing METERS of all Makes.

FACTORY AT ERIE, PA.

THEODORE D. BUHL, President. CHAS. H. JACOBS, Secretary-Treasurer.

DETROIT METER COMPANY,

DETROIT, MICH.

MAKERS OF...

GAS METERS.

OUR equipment embraces the Latest and Most Improved Machinery. We make our own Tin Plate. We claim for "BUHL" METERS, **Increased Durability,** with probability of **Fewer and Less Expensive Repairs,** and **More Accurate Adjustment.** Comparisons invited. Meters of other Makers promptly Repaired.

MAIL ORDERS SOLICITED.

Advertisement of

JOHN J. GRIFFIN & CO., Mfrs. of Gas Meters, etc.,

Nos. 1513, 1515, 1517, 1519 & 1521 Race Street, Philadelphia,

52 Dey Street, New York, 75 N. Clinton Street, Chicago,

Occupies this space every alternate week.

The Western Gas Construction Company's

IMPROVED SYSTEM

OF

COAL GAS APPARATUS

Has been or is under contract to be installed COMPLETE at

Spokane, Wash.
Butte, Mont.
Peoria, Ills.
Evanston, Ills.
Schenectady, N. Y., Reconstruction.
Racine, Wis.
Davenport, Iowa.
Moline, Ills., Reconstruction.
Valparaiso, Ind., Reconstruction.
Binghamton, N. Y.
Long Branch, N. J.
Durango, Col.
Defiance, O.
Charleston, Ills.
Waukegan, Ills.

FOR THE COMPLETE, PROGRESSIVE TREATMENT OF THE GAS FROM THE HYDRAULIC MAIN TO THE STATION METER,

Comprising gradual condensation, extraction of tar without loss of illuminants, extraction of ammonia with large percentage of CO_2 and sulphur by thorough washing and completing the extraction of sulphur by purification, either in ordinary purifiers, or our **IMPROVED BEAL DUPLEX PURIFIERS or DOHERTY-BUTTERWORTH PATENT PURIFIERS,** giving double the capacity of ordinary purifiers on the same floor area.

This system is thoroughly protected by patents issued or applied for, and does not infringe any other Process or Patents, and in almost all instances **makes use of existing apparatus.**

We have also supplied our Tar Extracting and Washing Apparatus to a number of works for use in connection with existing equipment.

WILLIAM HENRY WHITE,
EASTERN ENGINEER,
32 Pine St., New York.

The Western Gas Construction Co.,
FORT WAYNE, IND.